Columbium and other Aerospace Materials, pp 94 and 107

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Anaconda Strip-copper coils cut size and weight

Strip-copper coils cut the size and weight of electrical equipment ranging from watt-hour meters using relatively small coils to pole-mounted distribution transformers rated up to 500 Kva. In many instances operating characteristics can be improved as well.

Anaconda is now supplying high-quality copper strip for such uses. The quality of the copper has been extended to the finish, the edge, the packaging and handling. It is deburred, carefully packaged to prevent edge damage, and made available in a wide range of thicknesses and widths to satisfy all needs.

Whatever your use of coils, whatever size and capacity you wind, Anaconda copper strip promises economies in size and weight.

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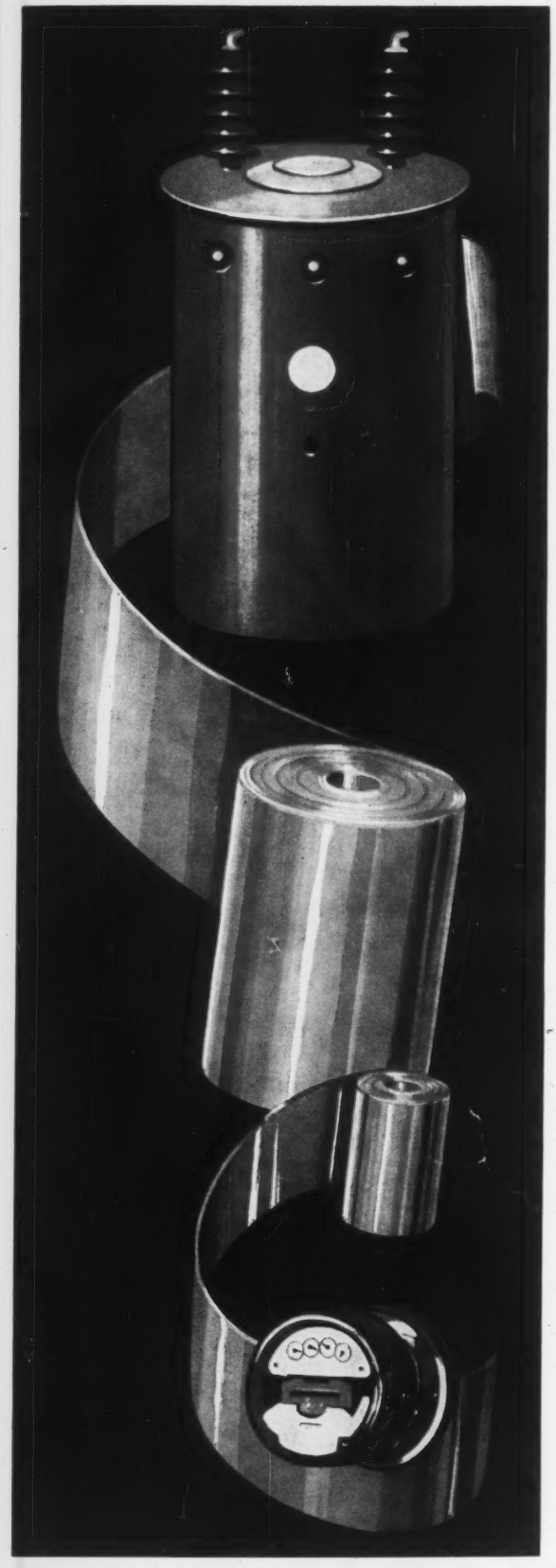

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DECEMBER, 1961 | VOL. 54, NO. 7

Materials in Design Engineering®

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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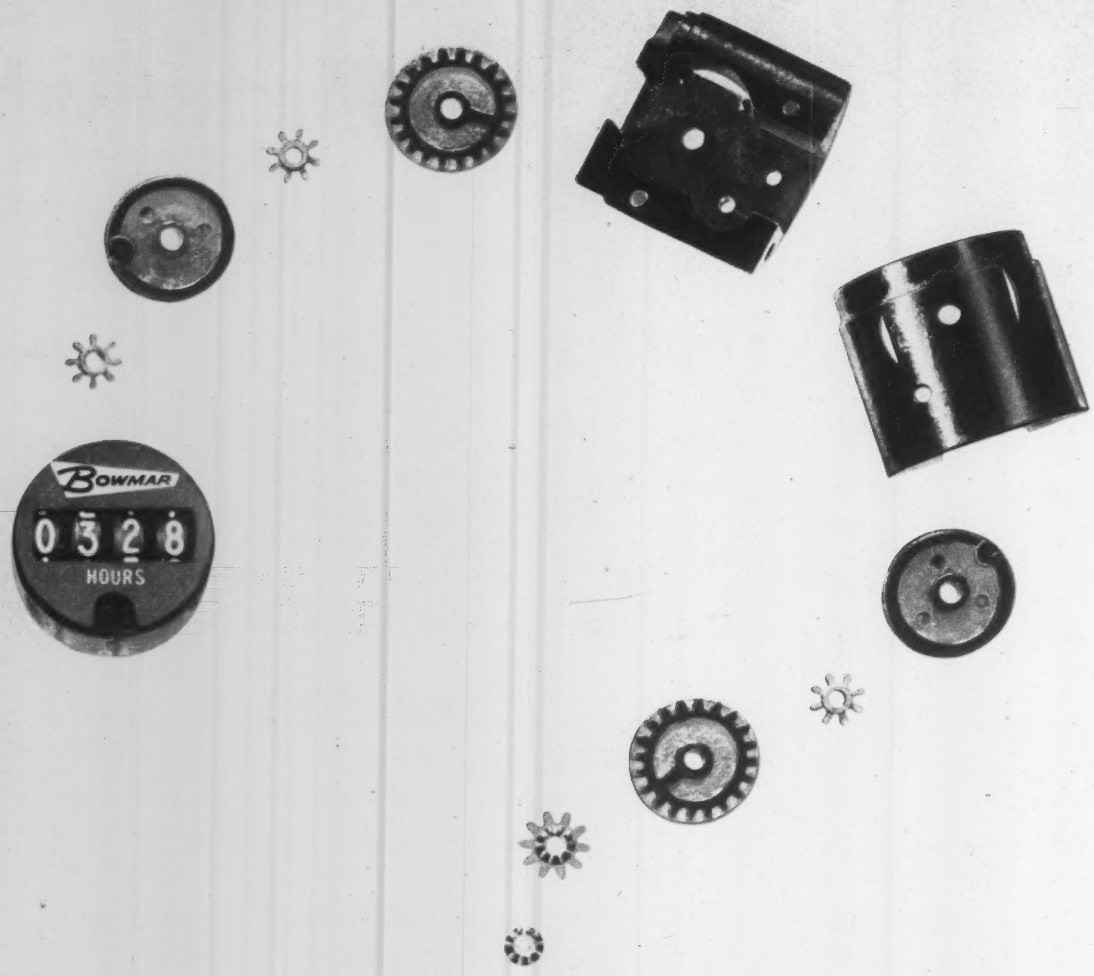

"are you getting your metal's worth?"

Without the castability and dimensional stability of Zamak, these almost microscopic gears and their precise housing would have been impossible to die cast. The eleven castings make up a counter assembly for an elapsed time indicator and together weigh less than half an ounce. A high degree of accuracy is essential. The ten-tooth bevel gear above the dime is just .063" in height. • Spectacular unit cost savings of 91.5% were achieved by zinc die casting, instead of machining the housing from aluminum bar stock and the gears and counter wheels from brass. All openings in the two-piece housing are die cast, even to the small crescent-shaped slots in the sides which permit the outermost gears to clear the housing wall. • This subminiature counter assembly is the heart of the Bowmar Instrument Corporation's Model 1440 Elapsed Time Indicator. It is a decimal type indicator, with numerals one-eighth inch high permitting readout up to six feet away. Standard, concentric circle-dial type indicators have numerals only a few hundredths of an inch high. • The Bowmar ETI must conform to military specifications and is used on digital computers such as the Army's FADAC (Field Artillery Digital Automatic Computer), where it determines the amount of time FADAC has operated, permitting equipment check-out at specified intervals. • These tiny castings demonstrate the tremendous versatility of the Zamak alloys, invented, pioneered and perfected by The New Jersey Zinc Company. Are you getting your metal's worth? To find out, write today to NJZ.

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Die castings by Hadlock & Temte, Inc., Chicago

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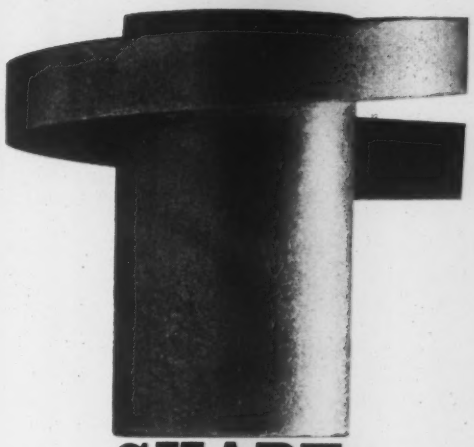
HOW TO DESIGN RUBBER PARTS . . .
A basic engineering guide to materials selection, design and specifications for elastomeric parts. How to interpret performance data . . . designing in compression and shear . . . tolerances and other shape factors . . . what you need to know about compounding and fabricating.

THERMOELECTRIC MATERIALS TODAY . . .
A progress report on promising materials and the problems that have to be solved before they find wider commercial application.

DESIGN FOR MINIMUM WEIGHT . . .
Four comprehensive bar charts compare important engineering materials as to their specific stiffness, weight-strength ratio, specific compressive strength and specific tenacity. Using one or more of these charts will allow a designer to arrive at an optimum lightweight design in most applications.

HOW RADIATION AND HEAT AFFECT PERMANENT MAGNET MATERIALS . . .
This article presents data for 11 common permanent magnet materials at both high and low irradiation levels and at three temperatures.

This Month's Cover *by Harry & Marion Zelenko shows the United States' future glide re-entry vehicle, ASSET, based on a sketch furnished by McDonnell Aircraft Corp.*



SHAPE
+
SLIDE
+
SAVINGS

This distributor cam once posed a materials selection problem for the Pinspotters Division of American Machine and Foundry—a problem solved by nonferrous powder metallurgy. As originally designed, the cam was machined from steel, but AMF was looking for increased slide characteristics to prevent the galling and binding which tended to occur with steel-to-steel contact.

Oil-impregnated prealloyed bronze powder provided the self-lubrication required—as well as fatigue strength of 5000 psi and ultimate tensile strength of 18,000 psi. And despite the tricky compacting technique called for by the continuously curved outer section, International Powder Metallurgy of Ridgway, Pennsylvania produces this more efficient redesign at a **90% cost saving.**

Lower cost, improved performance, solution of a tough design problem—these are the advantages to be gained through nonferrous powder metallurgy. To find out how to put this material and method to work for you, write today for your copy of "Designing for Pressed Brass and Nickel Silver Parts."

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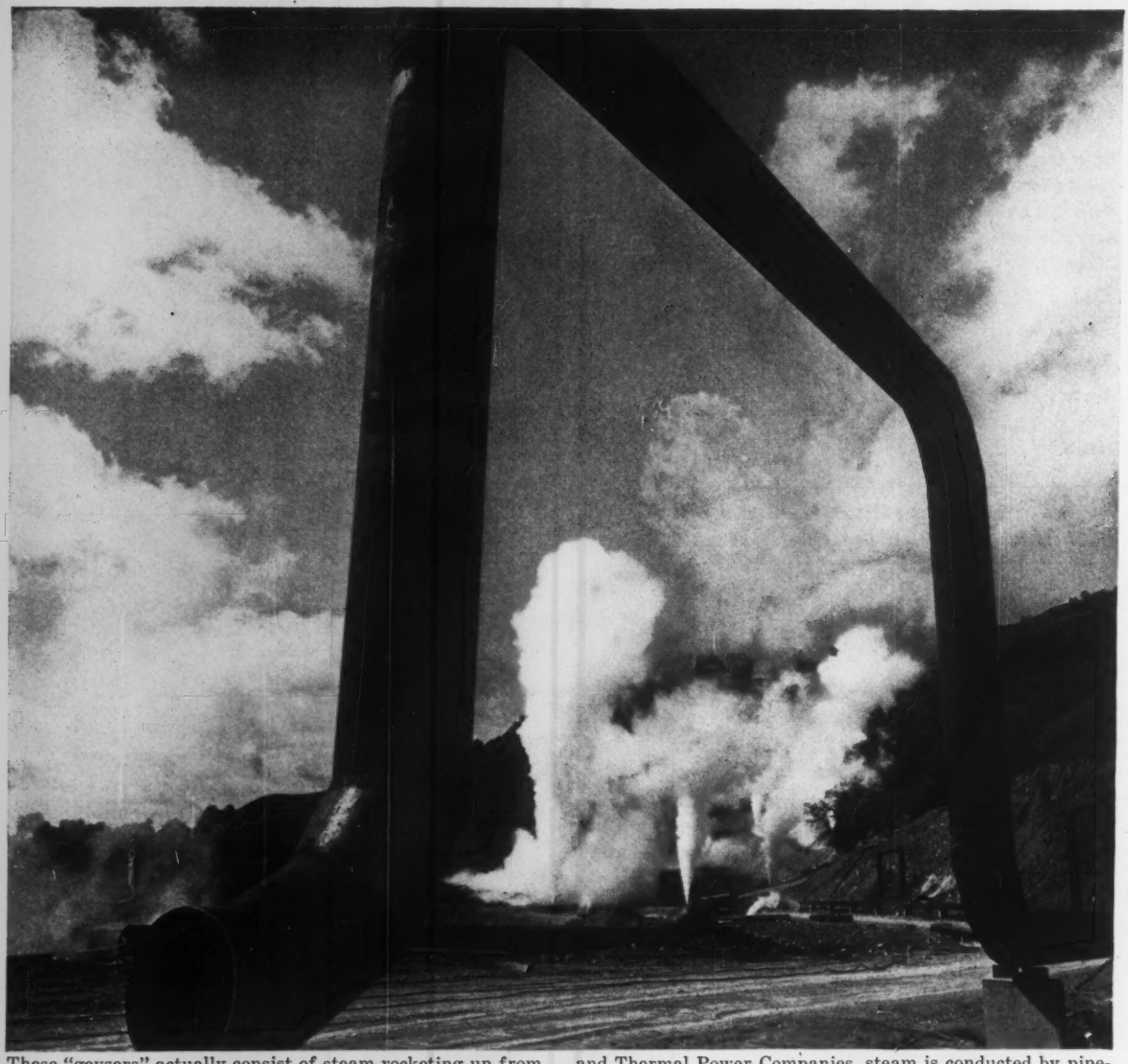


These "geysers" actually consist of steam rocketing up from deep in the ground. From this well area, operated by Magma and Thermal Power Companies, steam is conducted by pipeline to The Geysers Power Plant a quarter-mile away.

Now...electric power from geysers!

Nickel in stainless steel helps make possible America's first geothermal power plant.

Here's a power plant under construction in California that will produce enough electricity for a town of 50,000 people—all from the steam of geysers.

To withstand the continuous attack of this highly corrosive steam at The Geysers Power Plant, Pacific Gas and Electric Company selected stainless steel with nickel for all points where condensed steam contacts metal.

With nickel in it, stainless steel is more than a match for this corrosive steam. This ability plays a key role in turning out power every day of the year, with virtually no maintenance in a plant designed for unattended operation.

Nickel helps metals and alloys withstand the severest conditions. Nickel-containing metals safely hold liquid oxygen at a sub-zero cold that shatters many materials. America's first nuclear-powered merchant ship uses alloys with nickel in them to contain the tremendous pressures and corrosive conditions in its power plant. And an alloy with nickel in it will enable the famous X-15 rocket ship to make the hot ride home from space without burning up.

Does your company have problems of these kinds in a product or a process? Why not write to us about them. Perhaps nickel or one of its alloys can help you.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

NICKEL MAKES STEEL PERFORM BETTER LONGER

A new class of nonmagnetic alloys has been developed. Based on a titanium-nickel intermetallic compound, the alloys can be hardened to Rockwell C62—almost the hardness of tool steel. The alloys have good corrosion resistance and can be used at temperatures up to 1200 F. Potential uses: tools, temperature sensing devices, housewares, cutlery, auto trim and watch parts.
Source: Naval Ordnance Laboratory, Magnetic Materials Div., White Oak, Silver Spring, Md.

An electroless copper plating solution deposits a conductive film on plastics, rubber, ceramics, glass and other nonconductive and semiconductive surfaces. According to the developer, the new solution produces a dense, fine-grained, adherent copper deposit with a minimum of difficulty. Bath life is at least 24 hr at room temperature.
Source: Enthone, Inc., 442 Elm St., New Haven 8, Conn.

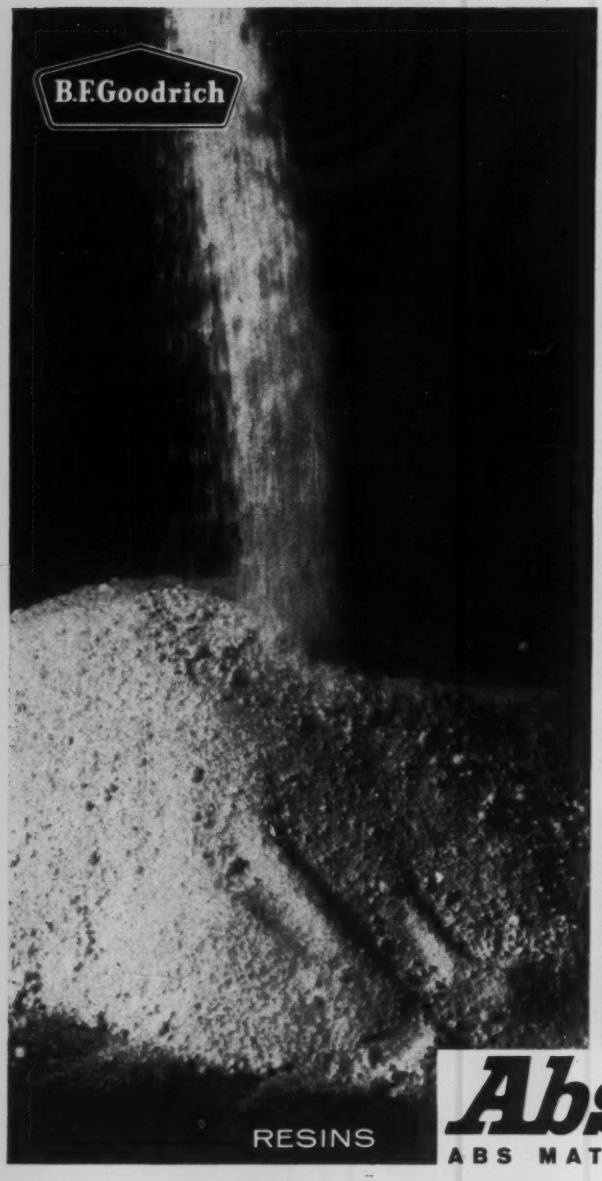
Parts made of a new monel metal powder can be used at temperatures up to 1000 F, are strong and ductile, and are resistant to attack by most corrosive media except strong acids and sulfurous gases. Test specimens have a tensile strength of 30,000 psi and a yield strength (0.1% offset) of 22,000 psi. Nominal composition is 67% nickel, 30% copper, the balance iron, manganese and silicon.
Source: U. S. Graphite Co., Div. of Wickes Corp., Saginaw, Mich.

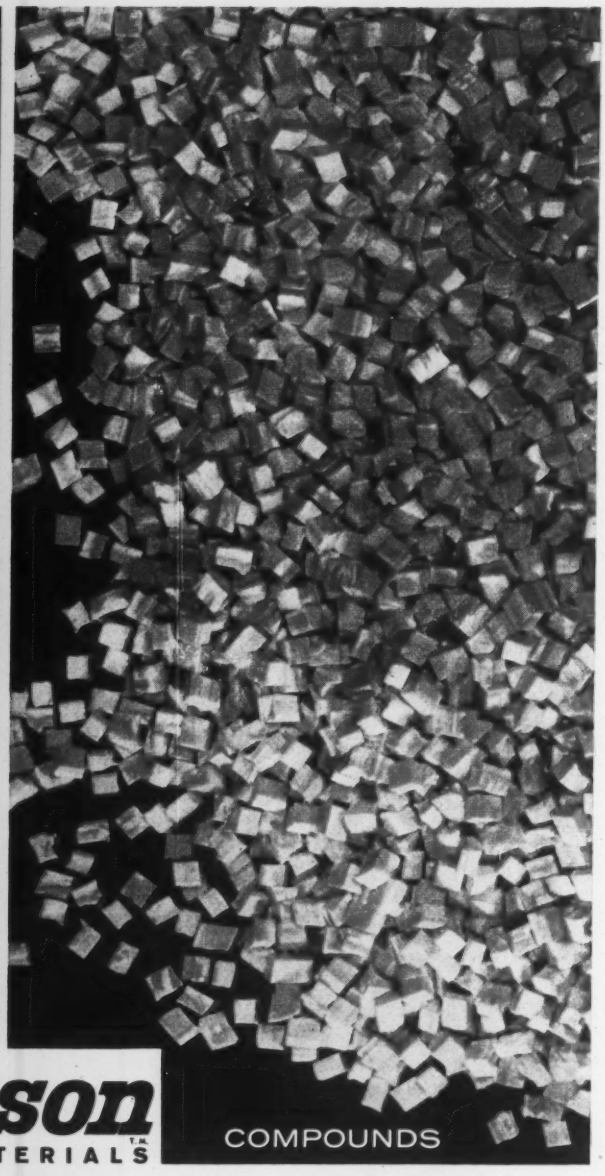
More reliable solder connections on electronic and other devices are said to result from a new tin-lead solder that has 33⅓% greater flow than conventional tin-lead solders. The material consists of a flux-coated tin-lead core that has been covered with an outer layer of the solder. It is available in wire down to 0.032 in. dia.
Source: Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

A new series of aluminum die casting alloys is said to have the following advantages when compared to conventional aluminum die casting alloys: 1) better machinability, 2) brighter surface finish, 3) less porosity, and 4) increased fluidity. The alloys, composition undisclosed, are supplied to standard or custom specifications.
Source: Apex Smelting Co., 2537 W. Taylor St., Chicago 12.

A new lubricant based on molybdenum disulfide and TFE resin is said to provide excellent wear resistance when used on wood, metal, rubber, ceramic, glass and plastics parts. The solid-film lubricant is unaffected by water and most solvents, and has good lubricating properties over the temperature range —459 to 400 F. It air dries overnight at room temperature.
Source: Lockrey Co., Southampton, N. Y.

Semi-inorganic plastics of the phosphonitrilic chloride family have been announced in developmental quantities. Aimed at the 500 F and above service temperature range, the materials are said to feature flame resistance, retention of electrical and mechanical properties at high temperatures, and excellent environmental resistance. The new materials are initially available as resins for compression molding com-





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pounds, and as a varnish type of coating. Adhesives, tapes and other coatings are likely in the future.

Source: General Dynamics Corp., Advanced Products Dept., P. O. Box 6231, San Diego 6, Calif.

One way to overcome the problem of welding aluminum to steel is to use a newly developed aluminum-clad low carbon steel strip. The clad metal is used as an intermediate to weld the steel side of the clad metal to steel and the aluminum side to aluminum. Straight lengths or coils of the clad metal are available in widths up to 12 in. and in thicknesses up to 0.100 in. The clad metal can be supplied with an aluminum layer up to 50% of the total thickness.

Source: Metals & Controls Inc., Div. of Texas Instruments Inc., 34 Forest St., Attleboro, Mass.

Boron filaments for high strength, lightweight structural composites are under development. Tensile strength of 500,000 psi and a modulus of 55 million psi have been reported for 4-mil dia filaments, and significant strength is reported retained at temperatures as high as 1800 F. Initial applications may be in filament-wound reinforced epoxy structures. Filaments over 700 ft long have been produced; a continuous process is under development.

Source: Texaco Experiment Inc., Richmond 2, Va. Developed under Air Force sponsorship.

A new class of lightweight structural materials for use in missiles, rockets and satellites has been announced recently. The materials, described as beryllide intermetallic compounds, are made from beryllium metal chemically combined with a refractory metal. The developer says the top temperature limit for the new beryllides is about 50% higher than that for iron, cobalt or nickel-base superalloys which runs about 1900 F. First materials to be introduced: beryllium-tantalum compounds.

Source: Brush Beryllium Co., 4301 Perkins Ave., Cleveland 3.

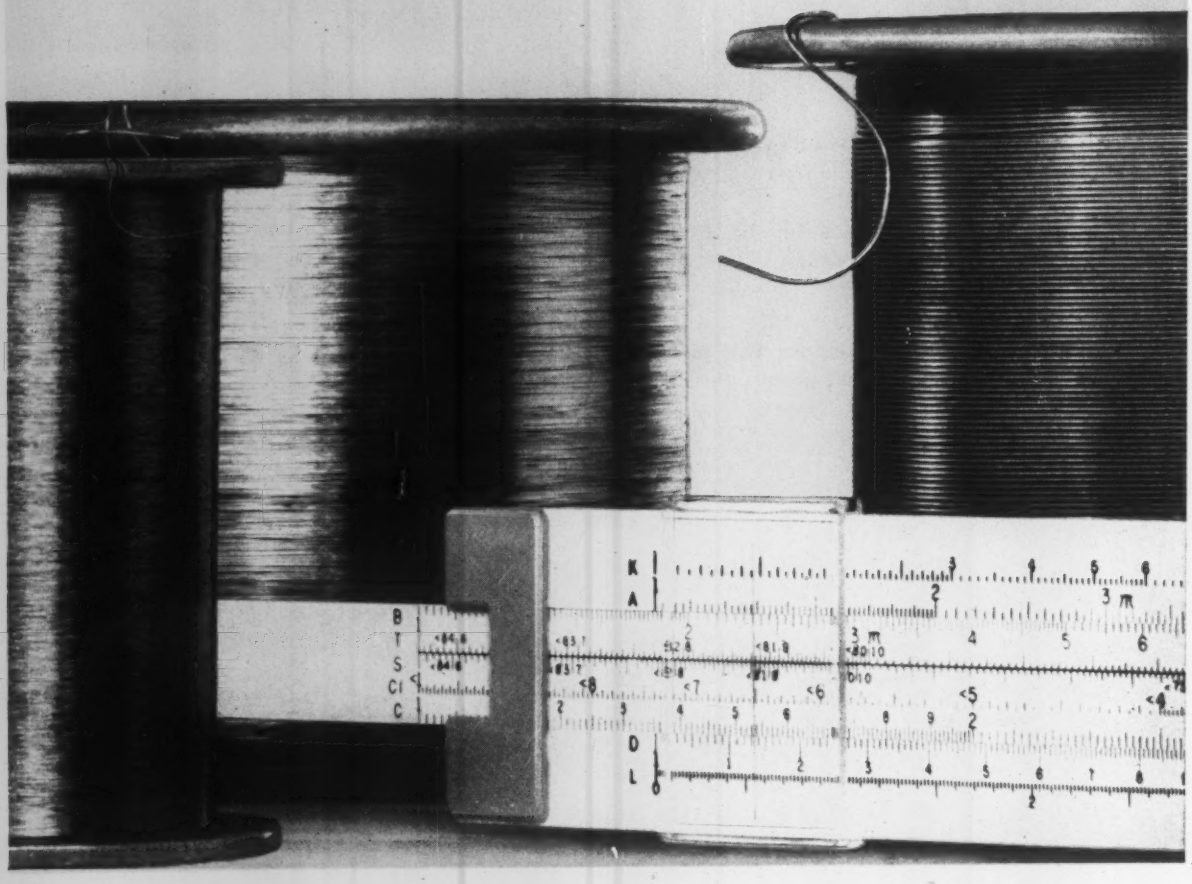
A new alloy for electroformed parts has been developed. Chief advantage of the material is that it has a low stress level, permitting the forming of intricate shapes without cracking. Although composition has not been disclosed, the developer says the alloy has a thermal conductivity slightly less than that of nickel and an expansion coefficient close to that of cobalt. Parts made of the alloy can be used at temperatures up to 3000 F.

Source: Value Engineering Co., 2320 Jefferson Davis Hwy., Alexandria, Va.

Acetal plastics parts can be painted and bonded easily if you first treat them in a special chemical solution, air dry at 100-250 F, rinse with water, and finally air dry at room temperature. According to the developer, this new pretreatment creates uniformly distributed anchor points over the entire surface of the part. Nitrocellulose and acrylic lacquers, epoxy and urethane enamels, and epoxy and other types of adhesives adhere well to treated parts of acetal and other thermoplastics.

Source: E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Del.

SYLVANIA MAKES ALL THREE—ALLOY, CLAD AND PLATED WIRE



One way to conserve engineering time

—get an unbiased recommendation on wire from Sylvania

Rapid changes in high-temperature equipment plus the continued evolution in components mean this: it doesn't pay to get mired down by noncreative engineering details. Example: which wire to use to meet conductivity needs in corrosive or oxidizing atmospheres?

To make the most of your engineering time, call on *Sylvania* to help you with wire specs. Sylvania knows wire—and the particular advantages of each kind. Of all major manufacturers, only Sylvania makes all three types of bare wire—alloy, clad and plated. They're available in a complete range of sizes—.002″ to .250″. Each retains optimum characteristics up to recommended operating temperatures.

You know that a Sylvania recommendation will be objective, based on your needs, and not limited by what the supplier can supply. Full details—plus time saving help—are yours when you write Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

For more information, turn to Reader Service card, circle No. 351

ONE-COMPONENT

Epoxy Adhesives · Coatings · Castings

made practical by amine-loaded molecular sieves

■ Stable, one-can liquid epoxy resin systems that cure relatively rapidly at room temperature and with low exotherm are now practical. Such systems can be prepared by using new types of so-called "chemically loaded molecular sieves" developed by Linde Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17. These new materials permit the catalyst or hardener to be intimately and uniformly premixed with the resin, yet remain completely isolated from it until needed.

Reduce waste and time

Benefits of such systems in adhesives, coatings or potting applications include: 1) both reduction in waste due to inaccuracy in mixing and reduction in mixing time, 2) virtually unlimited pot life, and 3) safety in handling toxic polyamines. Additional benefits are obtained in that the sieves substantially reduce exotherm during cure, and after cure serve as a filler material.

Although previously used in formulating various types of rubbers and epoxy molding compounds, this is said to be the first time loaded sieves have been available for liquid epoxy formulations. According to Linde, commercial one-can epoxy systems based on the sieves should be available sometime in 1962.

The sieves can be supplied loaded with a polyamine hardener, a modified polyamine, or a tertiary amine catalyst. They can be premixed with the liquid resin system and stored in closed containers indefinitely. The resulting single-can system can be activated either by moisture displacement and/or heat.

How sieves work

Molecular sieves, first announced in '54, are synthetic crystals of metal aluminosilicates with a fine interconnected pore structure. The internal network of pores accounts for almost 50% of the total volume of the crystal.

Certain types of such sieves have been loaded with tertiary amine curing agents. The amine is adsorbed on the internal surface of each sieve and firmly "locked" within the crystalline structure. The epoxy molecule, being larger than the openings in the sieve, cannot enter, and thus the curing agent is effectively isolated from the liquid epoxy resin.

System remains liquid *after many months on the shelf when curing agent has been added in sieves. In contrast, epoxy resin at right has set up in a matter of minutes after adding liquid polyamine.*

According to Linde, the hardener or curing agent can be released from the sieve by using water as a displacing agent. In thin sections, such as coatings or glue lines, atmospheric moisture will serve. When thick sections are cast, as in potting applications, mixing a slight amount of water into the mix ensures thorough release. Systems can also be activated by heat alone.

Three types available

Three basic types of sieves are available for epoxy formulations:

1. Simple polyamine-loaded sieves provide a one-year shelf life and cure at room temperature if a displacing agent such as water is present during cure. This type is applicable to thin coatings or adhesives where atmospheric and substrate moisture are present. Cure time can be decreased by heating.

2. Modified polyamine-loaded sieves are used where heat of the order of 250-350 F can be applied in conjunction with water. Special modification is required if the polyamine is to be released by heat alone.

3. Tertiary amine catalyst-loaded sieves (e.g., triethylamine) can be activated either thermally or by water displacement, or both.

Cost of loaded sieves depends on cost of hardener and difficulty in loading the specific chemical. Commercial price should average about $3-$5 per lb. Loadings should range from as low as 3 to as high as 15% by weight of resin.

For more information, circle No. 600

Suitcase frames brightened up with . . .

New Bright Pickle Process for Magnesium

■ A new bright pickling procedure for magnesium is said to yield a better finish with less critical control than conventional methods.

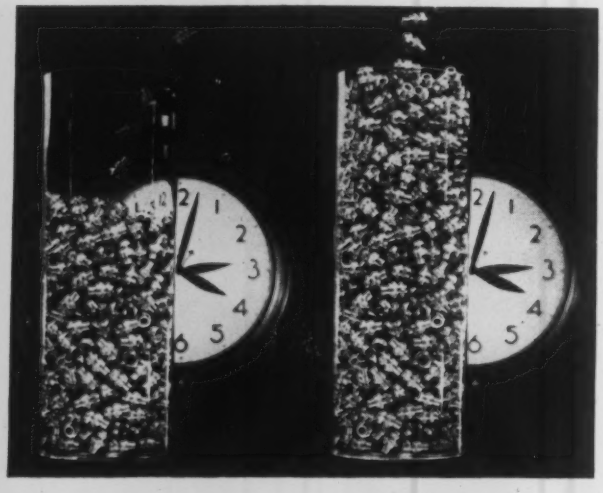
The process, based on a ferric nitrate solution recently developed by Dow Metal Products Co., is in operation in what is said to be the world's largest magnesium bright pickle line. This automated line applies the new nine-step dip process to magnesium suitcase frames at the Denver luggage plant of Shwayder Brothers Inc.

Appearance improved

Bright appearance for styling, and resistance to tarnishing in all-weather exposure are the principal requirements for the extruded suitcase frames. These parts formerly received a chromate conversion coating and a layer of metallic pigmented paint. This treatment has been replaced by the new pickling process and a coating of clear baking enamel to obtain a brighter, more metallic finish. The enamel, sprayed on electrostatically, provides durability and corrosion resistance.

Automated process

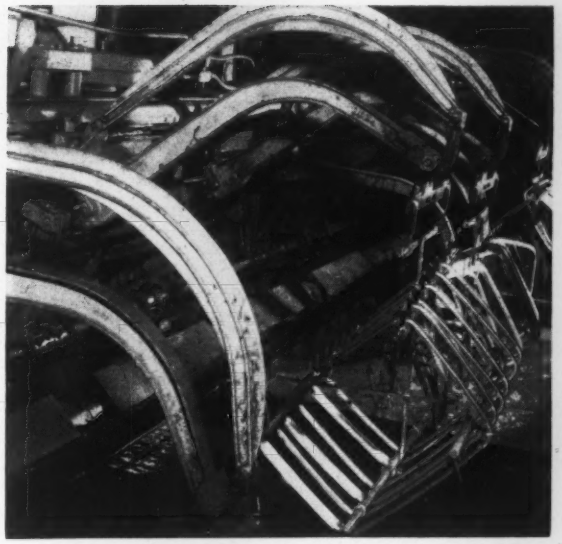
The ferric nitrate bright pickle solution used in the new process is designated Dow Chemical Treatment No. 21. This solution is said to be an improvement over Dow 15 and Dow 16, which have been subject to staining and difficult to control.



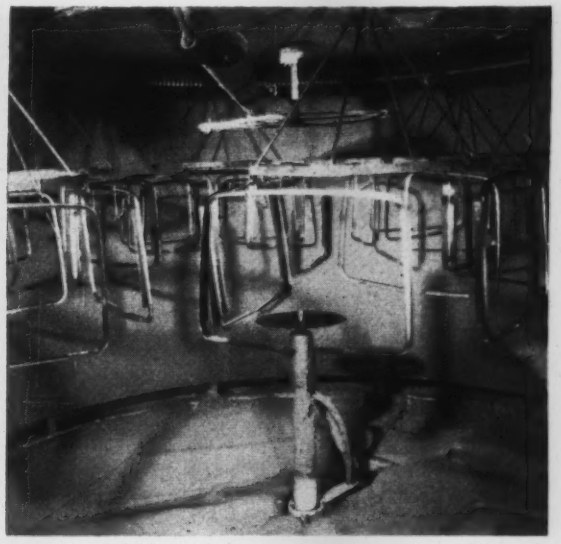
Machinability of Leaded

■ The spark plug shells in each container in the photo were produced on the same machine and with the same tools. The 1260 shells in the right container were made from La-Led X in the same time it took to make the 820 shells on the left from conventional leaded steel.

La-Led X is a tellurium-bearing leaded steel developed by Inland Steel Co., Chicago. Inland's production is almost entirely in the form of hot



***Ferric nitrate** immersion follows cleaning, prebrightening steps. Metal is then bleached and rinsed.*



***Electrostatic spraying** with clear enamel which is then baked. Coating protects bright surface.*

In the conveyorized line at Shwayder, stainless steel or nylon racks carry the magnesium frames through nine successive baths:

1. Alkaline cleaner, 2 min.
2. Cold water rinse, 12 sec.
3. 7% nitric acid prebrightener, 36 sec.
4. Cold water rinse, 12 sec.
5. Ferric nitrate bright pickle brightener, 2 min.
6. Cold water rinse, 12 sec.
7. Sodium carbonate bleach solution, 48 sec.
8. Cold water rinse, 12 sec.
9. Hot water rinse, 12 sec.

Total process time is 6 min, 24 sec. The nitric acid prebrightener acts as a buffing agent and removes from ½ to 1 mil of material. Including this step in the process also prolongs the life of the ferric nitrate bath and reduces total processing time.

The ferric nitrate bright pickle solution consists of:

Chromic acid ..... 24 oz
Ferric nitrate .....5 1/3 oz.
Potassium fluoride .... 0.35 oz
Water ..... to make 1 gal

This solution removes about 0.3 mil of metal. The purpose of the sodium carbonate bleach is to remove any stains not removed by the cold water rinse following the ferric nitrate bath.

At the end of the dip operation, the frames pass through a drying oven on another conveyor. Then the parts are electrostatically sprayed with a clear enamel which is baked for 15 min.

For more information, circle No. 601

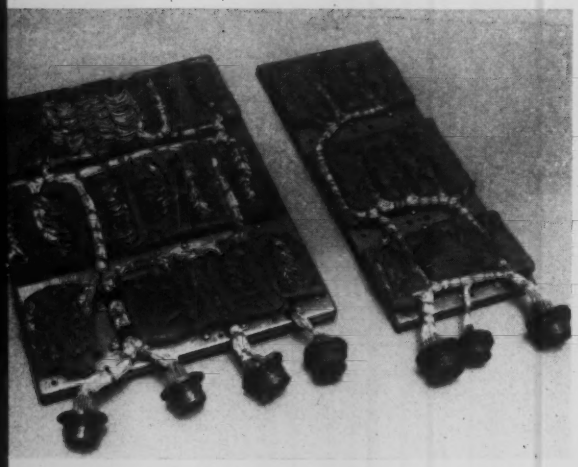
Steel Boosted 3½ Times

rolled bars which are sold to companies such as La Salle Steel Co., Hammond, Ind., for final processing by cold finishing.

Adding tellurium to a leaded steel permits a 350% increase in machining speed compared with the standard screw machine steel, B1112. Cost of the tellurium addition is $15 per ton for carbon steels and $20 per ton for alloy steels.

La Salle, in cooperation with Cone Automatic Machine Co., has extensively tested the machinability characteristics of La-Led X. Steel from several different heats was furnished to machine spark plug shells from 13/16-in. dia hexagonal bar stock. Bars were machined at 618 sfpm, 3½ times the machining speed recommended for B1112. Tool wear during the high speed tests was normal and drills showed no appreciable wear.

For more information, circle No. 602



Foamed resin insulation is easy to apply (see right) and protects against heat and shock.

Silicone Foam Insulates Missile Parts

■ Silicone resin foamed in place provides electrical insulation for Atlas missile inertial guidance parts as shown above.

In addition to insulating components electrically, the foam must protect them from extreme temperature variables, high acceleration and vibration. And light weight is a must.

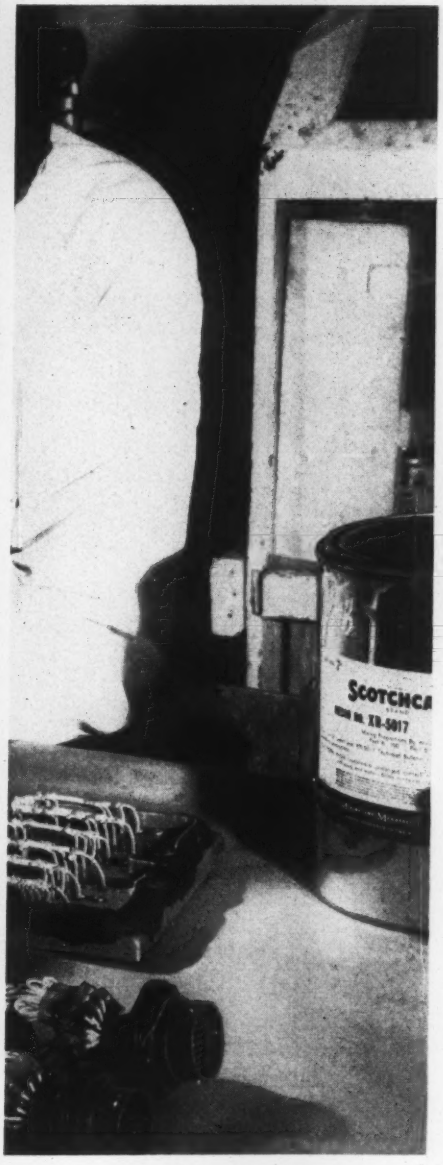
Environmental extremes

Before launching, the components must be protected from corrosion and dampness caused by underground temperature and humidity conditions. This is accomplished by the closed cell structure of the silicone foam which shows negligible water absorption after 24 hr exposure at 90% RH.

Take-off generates severe acceleration, vibration and thermal shock. During a typical flight, temperature ranges between the extremes of –400 F and 1000 F. The foamed resin not only withstands these conditions but helps protect the equipment from them.

Applied with gun

Ease of application was an important factor in the choice of this insulating material. The resin used by General Dynamics/Astronautics for this service is "Scotchcast" XR-5017, a two-part composition produced by Minnesota Mining & Mfg. Co. Pot life is 30



to 45 min. The mixture is applied in a ½ to 1-in. layer using a pneumatic gun (see above).

Temporary metal molds keep the liquid material confined to the area to be insulated. The resin foams to two or three times the liquid volume and adheres to metals and plastics without a primer. Curing can be accomplished at room temperature, but is done at 150 F at Astronautics to reduce the time for the cure to 90 min.

Ultra-Pure Tungsten

Large crystals can be rolled into 0.005-in. strip.

Current interest in the fundamental properties of metals used for high temperature applications has sparked the development of new refining techniques to grow 99.9975% pure tungsten single crystals. Size of the crystals can range up to 10 in. long and 0.22 in. dia—large enough to fabricate small parts.

Two-stage process

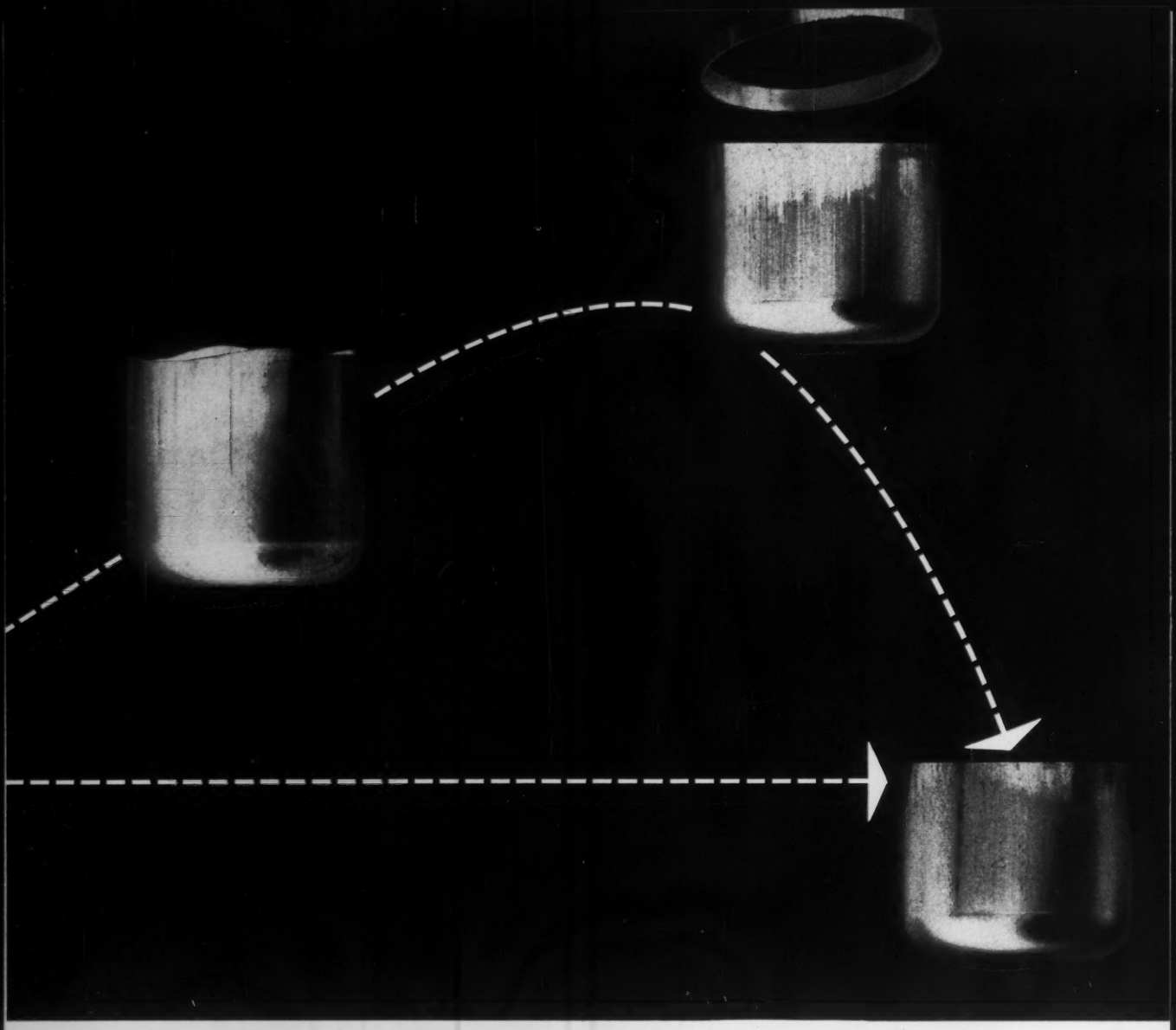
Ultra-pure single crystals are grown in two stages, according to the developers, Westinghouse Lamp Div., MacArthur Ave., Bloomfield, N. J. Starting material is a special high purity tungsten ingot. (The starting ingots, themselves, are produced by an undisclosed process developed specifically for this application.) The ingot is zone melted and refined in apparatus that uses electron beam heating, in a vacuum of better than 10^{-5} mm Hg, to produce the single crystals.

Ironically, after the high purity single crystals were produced, no existing analytical technique could precisely measure the gaseous and metallic impurities, present in only a few parts per million. Consequently, the Lamp Div. developed advanced techniques in optical spectroscopy, vacuum fusion and neutron irradiation analysis to verify impurity content.

Crystals are ductile

Although tungsten is usually considered to be a hard, brittle metal, difficult to machine or fabricate, Westinghouse says the single crystals are ductile down to –330 F.

Tungsten strip 3 ft long, ½ in. wide and 0.005 in. thick has been cold rolled from a single crystal, and wire has been drawn down to 0.030 in. dia. **For more information, circle No. 604**



ARE YOU TAKING THIS COSTLY PRODUCTION "DETOUR"?

The problem is a common one in steel drawing operations: How to eliminate scalloping or "ears"?

One way is to trim them. The other is to eliminate them—at the purchasing stage.

You can do this by specifying J&L Precision Non-Scalloping cold rolled strip steel. Through precise control of every production step, J&L has developed a low carbon strip *which is non-scalloping.*

Result: a major operation—trimming—can be saved. Also, you'll have fewer rejects and less down-time. These advantages mean more profitable production—and are especially important in operations involving progressive dies, where uniformity and protection of equipment are major factors.

Steel

Non-scalloping strip is just one of the full line of precision products backed by J&L's combination of specialized equipment and techniques, plus *experience.* For information, call your J&L Stainless and Strip Division representative or write to Dept. 1360.

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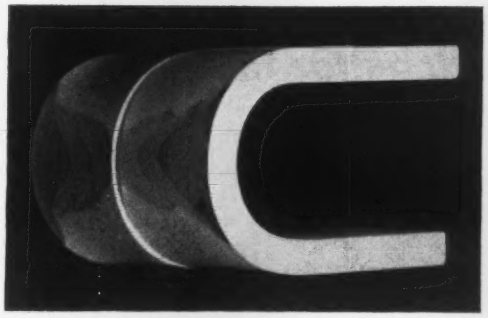

Single side bend *around a 2t rad in 3-in. weldment of 5083 made with 7/32-in. dia 5183 filler. Six passes were used. Side bend specimens were cut into two 1½ in. thick specimens according to ASME code.*

ALUMINUM:

Faster Welding...Better Heat Treatment

■ Now you can weld the 5000 series aluminum alloys faster and greatly reduce the possibility of stress corrosion cracking of 7075 alloy in the transverse directions, according to information just released by two important producers of aluminum.

Faster welding

A new method for submerged arc welding of thick aluminum plate uses filler wire up to 7/32 in. dia. By contrast, conventional gas metal arc (MIG) welding is generally limited to a maximum wire size of 1/8 in., with the greatest amount of welding done with 1/16-in. dia wire.

Developed by the Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Oakland, Calif., the new technique offers users five advantages:

1. Welding costs are reduced. A weld filler deposit rate of 15 lb per hr is common, and 20 lb per hr is possible in special applications. Conventional MIG welding deposits filler at 5 to 10 lb per hr.

2. Existing submerged arc equipment can be converted to use the larger diameter filler wires by replacing the flux and contact tube system with a water cooled inert-gas welding barrel of sufficient capacity.

3. Current density is radically lowered. Conventional welding with smaller diameter fillers requires 50,000 to 100,000 amp per sq in. as opposed to 15,000 to 30,000 with the larger wires.

4. Varying mixtures of argon and helium may be used as the shielding gas.

5. Welding time is decreased. In general only two welding passes are used with plate up to 1½ in thick. Multi-pass techniques are required for thicker metal (see photograph).

New heat treatment

A new heat treatment that virtually eliminates stress corrosion cracking in 7075 alloy has been developed by the Research Laboratories, Aluminum Co. of America.

MINIMUM MECHANICAL PROPERTIES IN THE T73 TEMPER[a]

Test Direction	Ten Str, 1000 psi	Yld Str, 1000 psi	Elong, %[b]
DIE FORGINGS			
Parallel to Predominant Grain Flow	66	56	7
Not Parallel to Predominant Grain Flow	61	52	3
ROLLED BAR AND ROD			
Longitudinal	66	56	10

[a]For sections 3 in. or less in thickness.
[b]In 2 in. or 4D.

Designated -T73, the new thermal treatment (details of which have not been disclosed) greatly increases the ability of 7075 to

(Continued on p 141)

MORE WHAT'S NEW IN MATERIALS

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CASE HISTORIES FROM
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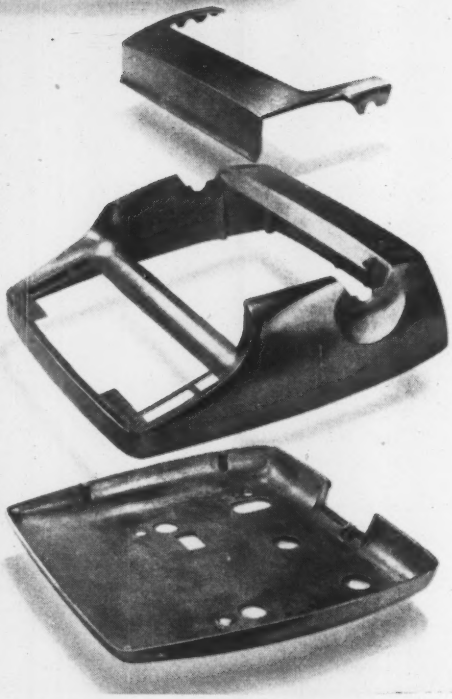
We may be the "reliable supplier" you need to help you improve your products. Why not get in touch with us and talk it over? Our field salesmen are waiting for your call.



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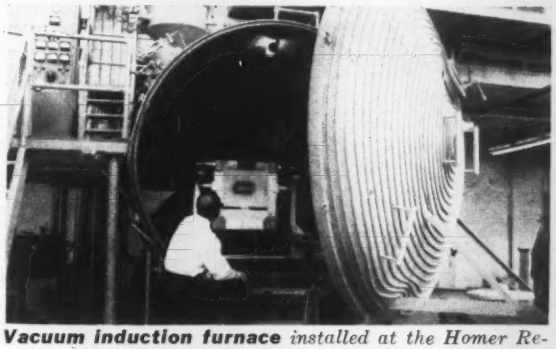
Better Steels, Alloys to Come from New Labs



Vacuum induction furnace *installed at the Homer Research Laboratories for studies in high purity metallurgy.*

Basic and applied research leading to new steels and copper alloys is the principal goal of new materials laboratories constructed by two prominent metals producers—Bethlehem Steel Co. and Anaconda Co.

Steel technology will be investigated at the new research facilities recently built by Bethlehem Steel Co. and dedicated to its board chairman, Arthur B. Homer. Close to 500 technical people are now working on development projects at the $25 million Homer Research Laboratories in Bethlehem, Pa. The company expects to double the size of this staff within the next five years in its efforts to develop new steel and improve existing grades, with special emphasis on the preparation of raw materials and the steelmaking processes.

The new experimental facilities include six complete spectrographic laboratories, an ultrasonic unit for high-frequency vibration of steel ingots during solidification, and pilot plant equipment such as the vacuum induction furnace pictured at left.

The effects of temperature variation, and of impurities and additives on copper alloys will be one of the principal areas of research at Anaconda American Brass Co.'s new Research and Technical Center at Waterbury, Conn.

About 100 scientists and technicians will conduct fundamental studies of copper alloys to fill in "many gaps in our existing knowledge." This work will include investigations into phenomena ranging from corrosion to precipitation hardening.

Thermophysical Topics Set for Symposium

The increasing number of engineers whose work requires a familiarity with thermophysical technology has led the American Society of Mechanical Engineers to include in the program for the Second Symposium on Thermophysical Properties special papers for the benefit of newcomers to the field.

Several review papers, prepared as introductions to various specialized aspects of this area of thermodynamics, will be given during the symposium, which the ASME Heat Transfer Div. will conduct at Princeton University, Jan 24-26.

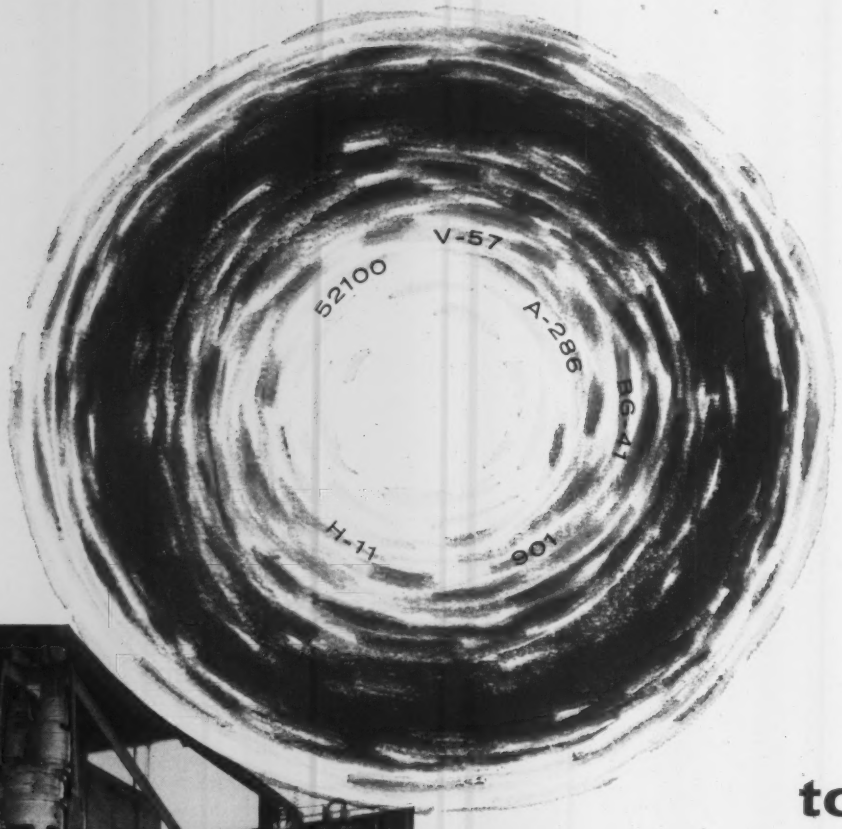
Radiation Processes in Plasmas, Transport Properties of Gases, High Temperature Thermal Property Measurements to 5000 F, and Significant Aspects of Non-Newtonian Technology are among the topics planned for this event.

New Materials, Equipment Offered at Metal Show

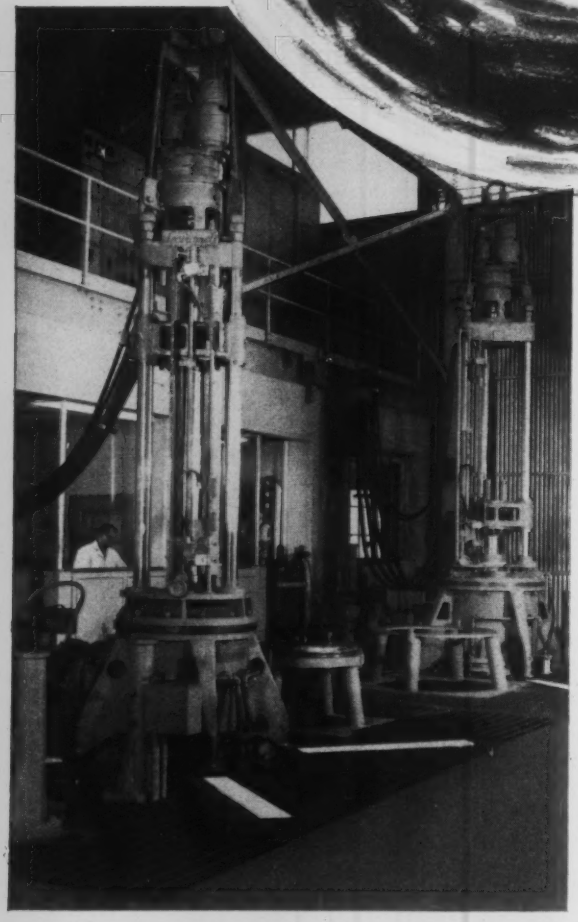
Exhibitors introduced several new developments in materials, and advanced test and fabricating equipment at the Metal Show recently held in Detroit and sponsored by the American Society for Metals.

- A new type of stainless steel was announced by Westinghouse Electric Corp. Called Kromarc-55, this alloy is designed prir ·ily for high temperature service and is said to be similar to the AISI 300 series, except that it has improved weldability.
- Vanadium-Alloys Steel Co. offered three new steels: Vascomax 250 and Vascomax 300, both 18% nickel alloys for applications requiring very high strength and ductility (these will be discussed in a forthcoming issue of M/DE); and Vasco Hypercut, a superhard high-speed steel.
- Tungsten and ductile molybdenum in sheet and

AT LATROBE . . . PROGRESS HAS THE GREEN LIGHT



jet age roars to new horizons



PROGRESS MOVES FORWARD! CAPACITY MORE THAN DOUBLED! NEW 30" CONSUMABLE ELECTRODE FURNACE JOINS 20" UNIT.

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plate 2 ft wide were shown by General Electric Co.

New equipment featured —Many areas of materials engineering may benefit from new testing and fabricating machinery that was exhibited:

- A friction welding machine developed by American Machine & Foundry Co. for fast, sound welding, and intended especially for joining dissimilar metals (see M/DE, Oct '61, p 141).
- An ultra-high temperature mechanical testing machine built by Arcweld Mfg. Co. Electron beam heating is used to produce test temperatures as high as 6000 F in a vacuum.
- Shaped hole spinnerettes for producing synthetic fibers in a wide variety of cross sections. J. Bishop & Co. offers these "textile dies" which are said to provide unusual effects such as glitter, high bulk and crease resistance in fabrics.
- A high energy electron beam welder developed by Hamilton Standard Div. of United Aircraft Corp. for welding refractories and joining metals to ceramics.

A Materials Application Center was one of the features of the show. This million-dollar display effectively showed how materials are used in different applications according to their engineering properties.

Maximum strength steels—A highlight of the technical congress held in conjunction with the show was the 1961 ASM Campbell Memorial Lecture. "Atoms and Imperfections" was the subject of this year's lecture, given by Dr. Lawrence Darken of United States Steel Corp. Scientists have high hopes of developing polycrystalline ferrous materials with strengths approaching 2 million psi, Dr. Darken stated. This would be achieved by controlling the interactions of material imperfections such as dislocations and vacancies.

Ten organizations took part in the technical congress; overflow attendance at practically all sessions indicated the strong interest in the subjects.

Two Materials Symposiums Sponsored by Military

Current research findings on subjects ranging from ceramics and magnetic core materials to high temperature adhesive bonding were presented recently at two symposiums on "Space Age Materials" and "Structural Adhesive Technology."

Refractory center created—General B. A. Schriever, Commander of the Air Force Systems Command, opened the "Space Age Materials" meeting sponsored by the Air Force at Phoenix, Ariz., and announced the establishment of an Air Force Ceramics and Graphite Technical Evaluation Center. The new center, located at Wright-Patterson Air Force Base, Dayton, Ohio, will collect, evaluate and disseminate technical information on research and development work in ceramics, intermetallics, cermets, ceramic composites and graphite.

The "Structural Adhesive Technology" symposium presented by the Army Ordnance Corps at Picatinny Arsenal in Dover, N. J., made it apparent that this technology, especially valuable in joining dissimilar materials for optimum performance-weight characteristics, is coming of age.

Two of our editors who attended these symposiums have summarized many of the important developments presented, beginning on pp 89 and 94 of this issue.

Magnesium Growing in Non-Defense Uses

Today more than 70% of the total magnesium used in structural applications appears in everyday products for industrial, commercial and consumer needs. This estimate comes from The Magnesium Assn. which displayed over 150 non-defense magnesium products at its recent annual meeting.

A strong conviction that "magnesium has graduated from the 'wonder' metal stage, and taken its place with 'older' metals as a recognized engineering material" led the association to conduct a panel discussion on standards as one of the meeting's focal points. The aim of this discussion was to study the specific requirements of the broadening consumer market for magnesium, and eliminate variances in standards and specifications for defense and non-defense purposes.

An investigation of unconventional fabricating processes has been stimulated, the association reports, by this expansion of the nonmilitary uses of magnesium alloys. Among the more recent developments of this type covered at the meeting were:

1. Adhesive bonding for joining several simplified castings, thereby avoiding complicated casting techniques. This could result in lower total cost and increased reliability.

2. Chemical milling for contouring, tapering or stepping parts such as airframe components to meet the requirements of airflow and weight reduction.

News of Societies

American Standards Assn. has awarded Louis Polk, Sheffield Corp., the Howard Coonley Medal for establishing high standards for dimensional quality control and for the advancement of standardization and its significant role in American economy.

Society of Plastics Engineers has announced the following officers for 1962: president—J. R. Lampman, General Electric Co.; vice-president, engineering—J. M. Berutich, Haveg Ind. Inc.; vice-president, administration—R. B. Bishop, Research Assoc., Holy Cross College; secretary—G. P. Kovach, Foster Grant Co., Inc.; treas.—S. H. Greenwood, Jr., F. J. Stokes Corp.

IMPACT!

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As the spikes got longer and sharper, steel, rubber and a variety of plastics were tried in the search for a "lift" that would take the punishment without leaving the scars of fashion in floors and carpeting. Then TEXIN, the new moldable urethane elastomer, was developed by Mobay—and the rest is another success story for the well-heeled shoe industry.

This is just another case where changes in product design proved too much for older materials; where only a completely new material could provide the answer.

If you're redesigning a part now that calls for a heavy-duty elastoplastic—one that wears like steel but works like rubber—and can be injection molded or extruded by fast, low-cost production methods, look at TEXIN before you take another step.

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News OF INDUSTRY

Coming Meetings

METAL JOINING SYMPOSIUM, Pennsylvania State University. University Park, Pa. Dec 11-13.

AUTOMOTIVE ENGINEERING CONGRESS & EXPOSITION, Society of Automotive Engineers. Detroit. Jan 8-12.

4TH ANNUAL MECHANICAL WORKING CONFERENCE, Metallurgical Society of AIME. Chicago. Jan 17.

THERMOPHYSICAL PROPERTIES SYMPOSIUM, Princeton University. Princeton, N. J. Jan 24-26.

18TH ANTEC, Society of Plastics Engineers. Pittsburgh. Jan 30-Feb 2.

17TH REINFORCED PLASTICS DIV. CONFERENCE, Society of the Plastics Industry, Inc. Chicago. Feb 6-8.

GOLDEN GATE METALS CONFERENCE, San Francisco. Feb 15-17.

AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, annual meeting. New York City. Feb 18-22.

4TH NATIONAL CONFERENCE ON APPLICATION OF ELECTRICAL INSULATION. Washington, D.C. Feb 19-22.

SOCIETY OF VACUUM COATERS, 5th annual technical conference. Cleveland. Mar 6-7.

STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting. Chicago. Mar 12-13.

AMERICAN CHEMICAL SOCIETY, 141st national meeting. Washington, D.C. Mar 20-29.

SOCIETY OF THE PLASTICS INDUSTRY, INC., 19th western section conference. Coronado, Calif. Apr 4-6.

METALS ENGINEERING CONFERENCE, American Society of Mechanical Engineers. Cleveland. Apr 9-12.

SOCIETY FOR NONDESTRUCTIVE TESTING, INC., national convention. Cleveland. Apr 9-13.

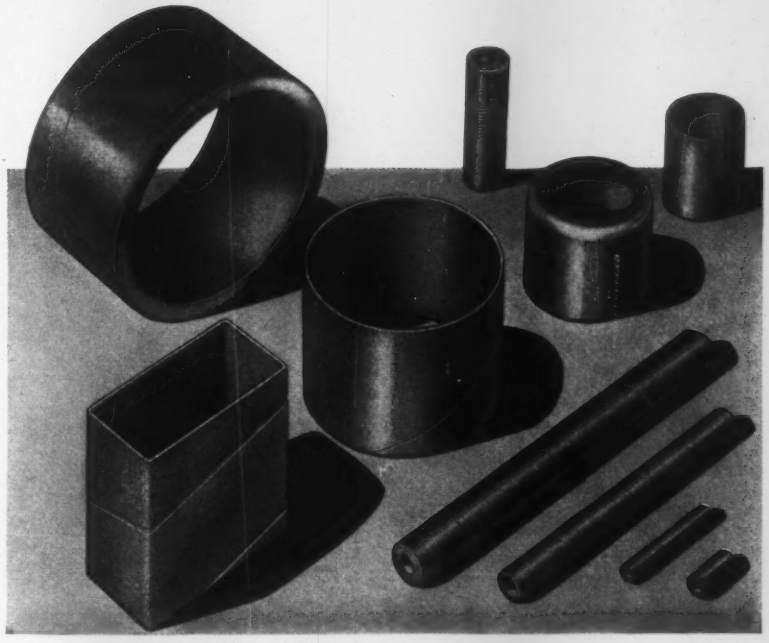
AMERICAN WELDING SOCIETY, 43rd annual meeting and exposition. Cleveland. Apr 9-13.

SPRING TEXTILE ENGINEERING CONFERENCE, American Society of Mechanical Engineers. Raleigh, N.C. Apr 11-13.

REFRACTORY METAL SYMPOSIUM, Metallurgical Society of AIME. Chicago. Apr 12-13.

AMERICAN SOCIETY FOR METALS, regional conference and exhibition on materials and materials processing. Houston, Tex. Apr 17-19.

19TH ANNUAL METAL POWDER INDUSTRIES FEDERATION, technical conference and show. Philadelphia. Apr 24-26.



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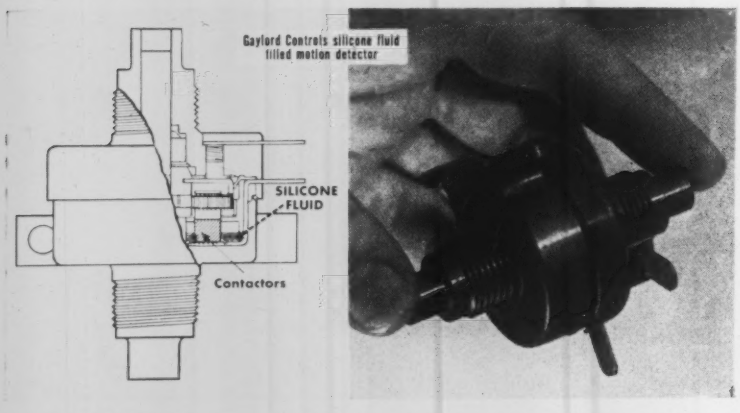
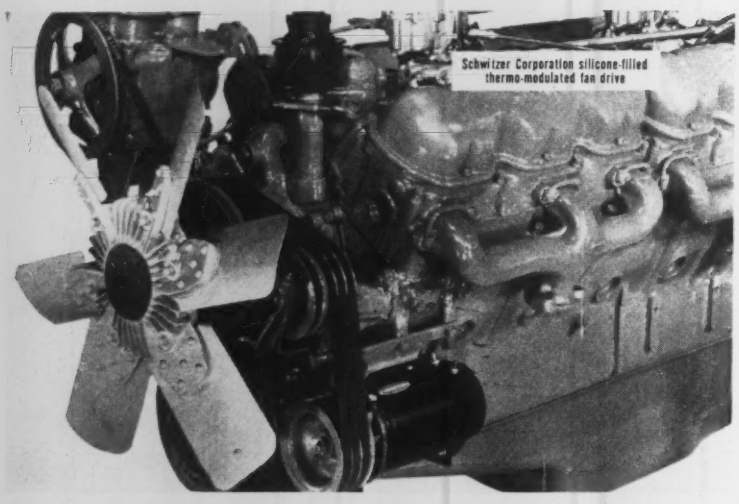
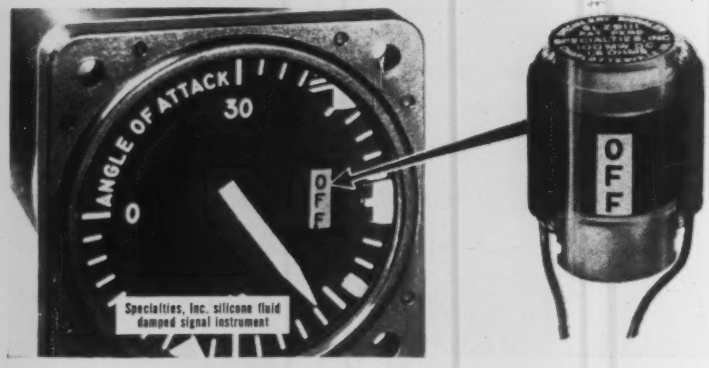
Dividend for designers



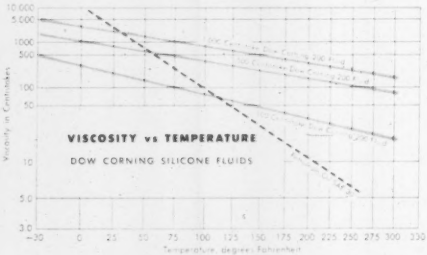




How to make your designs more versatile

Even the best device can be made more versatile, more practical, more efficient by engineering it to utilize the advantages of Dow Corning silicone fluids. Here's what these advanced engineering materials have to offer designers.

Stability to Heat, Cold. Dow Corning silicone fluids retain near-constant viscosity over wide temperature spans — help assure uniform, dependable performance in spite of temperature fluctuations. Damping effect, for example, only decreases from 3 to 1 over a temperature rise from minus 40 to plus 160 F. Under identical conditions, damping effect of a petroleum fluid decreased from 2500 to 1.



Long Life. Highly resistant to oxidation, Dow Corning silicone fluids undergo virtually no change even after long term service — are nonsludging, nongumming. Silicone fluids are inert . . . will neither corrode metals nor cause rubber to swell . . . have no harmful effect on component parts of devices or systems.

Good Compressibility. For liquid springs, shock absorbers and similar equipment, Dow Corning produces special silicone fluids that offer unusual compressibility in addition to all the other desirable properties that characterize silicone fluids. These compressible fluids make possible reductions up to 30% in oil chamber size . . . save vital weight and space.

For detailed information and technical assistance in dapting silicones to your products, address Dept. 7424, Dow Corning Corporation, Midland, Michigan.

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Comments on *Materials Selector Issue*

To the Editor:

". . . This is a very useful collection of data and is referred to frequently . . ."

P. J. McCarthy
Aluminum Co. of America
Pittsburgh, Pa.

To the Editor:

". . . Your *Materials Selector* is a very useful reference for designers and Materials Engineers . . ."

Dr. Joseph Remenyi
Sherman Oaks, Calif.

To the Editor:

". . . Your latest *Materials Selector Issue* is an extremely convenient reference book . . ."

John E. Anderson
Product Manager
Gilman Engineering & Mfg. Co.
Janesville, Wis.

To the Editor:

". . . I feel that the publication is a valuable tool in my work and will become a constant reference source in my work . . ."

E. J. Masucci
Reproducibility Engineer
General Electric Co.
Defense Electronics Div.
Utica, N. Y.

To the Editor:

". . . Just received the new *Materials Selector*. It is the most valuable thing I have in my work . . ."

George K. Kocher
Inventor, Research and Design Engineer
White Haven, Pa.

Our thanks to these readers, not only for the kind comments, but also for their suggestions on how we may improve next year's issue.

Shark-proof shrimp nets

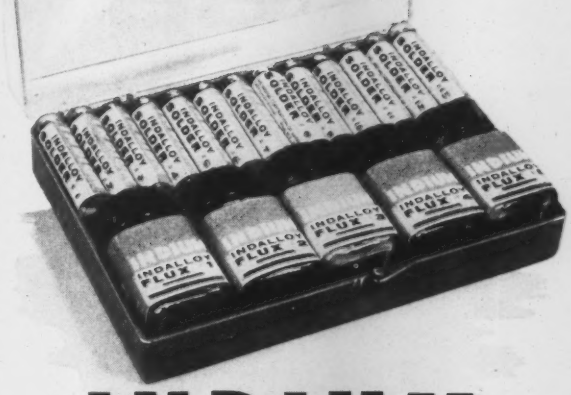
To the Editor:

Having read your Letters to the Editor column for some time, it occurs to me that some of your readers might be able to help me with an unusual materials problem.

We wish to shark-proof shrimp nets by means of a protective sleeve around the rear of the net. The sleeve would consist of rings having an i.d. of 1⅜ in. and an approximate o.d. of 1⅝ in. These rings will be fastened together with metallic clips so that they remain flexible. Ordinary steel rings are too heavy; aluminum rings are too expensive.

The basic requirements are low price, salt water

ONE TEST
IS WORTH
1000 GUESSES



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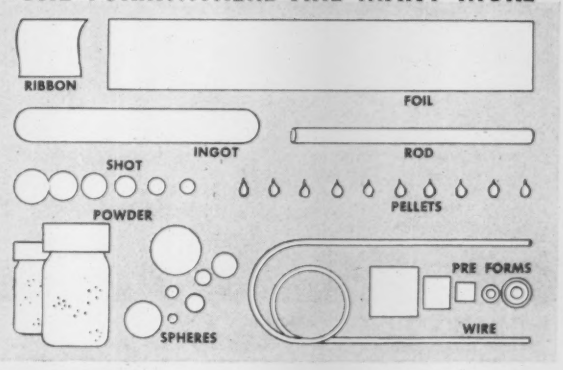

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or write for our free solder booklet:
"INDALLOY" Intermediate Solders. Dept. M-10

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1676 LINCOLN AVENUE • UTICA, NEW YORK

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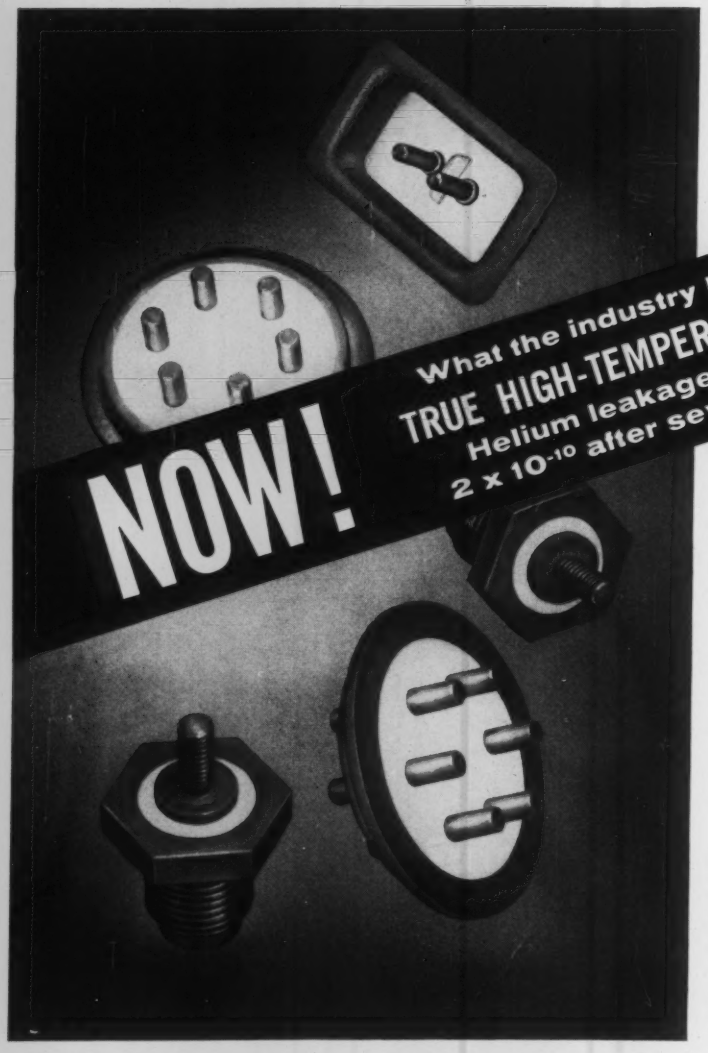
BIG NEWS in high-temperature precision-molded insulation

SUPRAMICA® 620 "BB" ceramoplastic


NOW!
What the industry has been waiting for . . .
TRUE HIGH-TEMPERATURE HERMETIC SEALS
Helium leakage rate cc/sec. less than
2 x 10-10 after severe environmental tests.

Need a precision-molded insulation material with total dimensional stability under the most adverse thermal cycling, operating to 1200°F. . . . or a material with previously unattainable combination of properties? Check these facts about new SUPRAMICA 620 "BB" ceramoplastic:

- **Maximum temperature endurance of material 1200°F. (unstressed). Heat distortion temperature of material 1100°F. (ASTM D648-264 PSI)**
- **SUPRAMICA 620 "BB" ceramoplastic can be precision molded to most intricate geometries with gauge-like tolerances.**
- **SUPRAMICA 620 "BB" ceramoplastic will not carbonize.**
- **Absolute hermetic seals achieved directly during the molding cycle. Components meet a helium leakage rate of less than 2 x 10^{-10} cc/sec., after the following environmental tests:**
  1. Samples heat shocked a total of 20 cycles from boiling water for 30 minutes directly to ice water for 10 minutes.
  2. Samples heat shocked a total of 5 cycles, from 350°C. for 1 hour directly to room temperature for 10 minutes, to -70°C. for 1 hour, to room temperature for 10 minutes.
  3. Samples heated to 500°C. for 4 hours and directly to room temperature.
- **Thermal expansion factor matches many metals and alloys.**
- **New SUPRAMICA 620 "BB" ceramoplastic features a dielectric strength of 270 volts/mil, 1/8" thickness per ASTM D-149.**

SYNTHAMICA® SYNTHETIC MICA · SINCE 1919 MYCALEX® THE INSULATOR · SUPRAMICA® CERAMOPLASTIC

MYCALEX
CORPORATION OF AMERICA

General Offices and Plant: 122 Clifton Boulevard, Clifton, N. J.
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World's largest manufacturer of ceramoplastics, glass-bonded mica and synthetic mica products

For more information, turn to Reader Service card, circle No. 344

resistance and relative immunity to shark attack. If any reader has a clue to offer, the shrimp fishermen of the Gulf of Mexico and Caribbean Sea will be most grateful.

JOSEPH S. ROBAS
Commercial Fisheries Consultant
Fernandia Beach, Fla.

Help needed on . . . electric mercury switches

To the Editor:

We would like to obtain general information and articles describing the following: 1) types of glasses used in electric mercury switches; 2) types of metals used for contacts; and 3) methods of making these contacts "mercury wetting."

SIDNEY V. WORTH
Chief Engineer
Electro Controls, Inc.
Philadelphia, Pa.

. . . controlled corrosion

To the Editor:

We are looking for information on a method of improving interference fits in metal mating parts by "controlled corrosion." The corrosion is induced chemically by treating the mating parts prior to assembly and is believed to have been practiced in the United States some years ago.

V. C. WATTS
Librarian
Production Engineering
Research Assn. of Great Britain
Leicestershire, England

. . . mineral powders

To the Editor:

I am interested in purchasing —70 + 100 mesh mineral powders having Moh hardnesses of 3, 5, 7, and 9. The minerals—calcite, appatite, quartz and corundum—will be used for abrasion testing of glasses. If these minerals are not available, I would appreciate information on other materials having the required size and hardness.

JAMES J. TUZZEO
Research Technologist
The Pfaudler Co.
Rochester, N. Y.

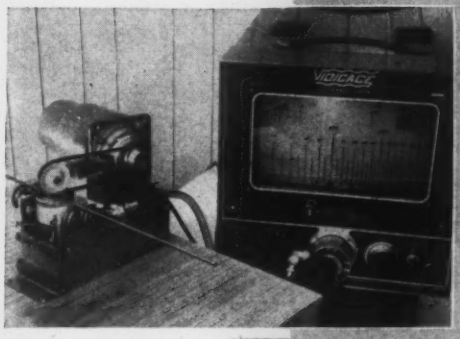
. . . fuel-less electrical engine

To the Editor:

Would you know any engineering inventors who could help me with my fuel-less electric engine. Sounds fantastic, but it's not. The design I have is not difficult to grasp. I have the fundamentals, but not the engineering skill.

H. PUSTERHOFFER
Cleveland, Ohio

ANOTHER ULTRASONIC FIRST...
THICKNESS GAGING WITHOUT CONTACT



Tube scanner for VIDIGAGE® thickness gaging without contact.

Thickness gaging by means of the ultrasonic resonance technique can now be accomplished by immersion without contact. This is extremely advantageous because:

- it eliminates transducer wear
- maintains uniform coupling of energy between transducer and work surface (this in turn makes the test more reliable!)
- avoids possible damage to work surface caused by transducer contact
- substantially increases inspection speeds

When the water column is of sufficient length the VIDIGAGE® does not respond to the water resonances. As a result the resonance thickness of the work piece can be detected by itself on the VIDIGAGE screen.

In order to take full advantage of this immersion system, the VIDIGAGE had to be modified. The modified VIDIGAGE then surpassed all expectations, especially in the gaging of small diameter, high accuracy tubing.

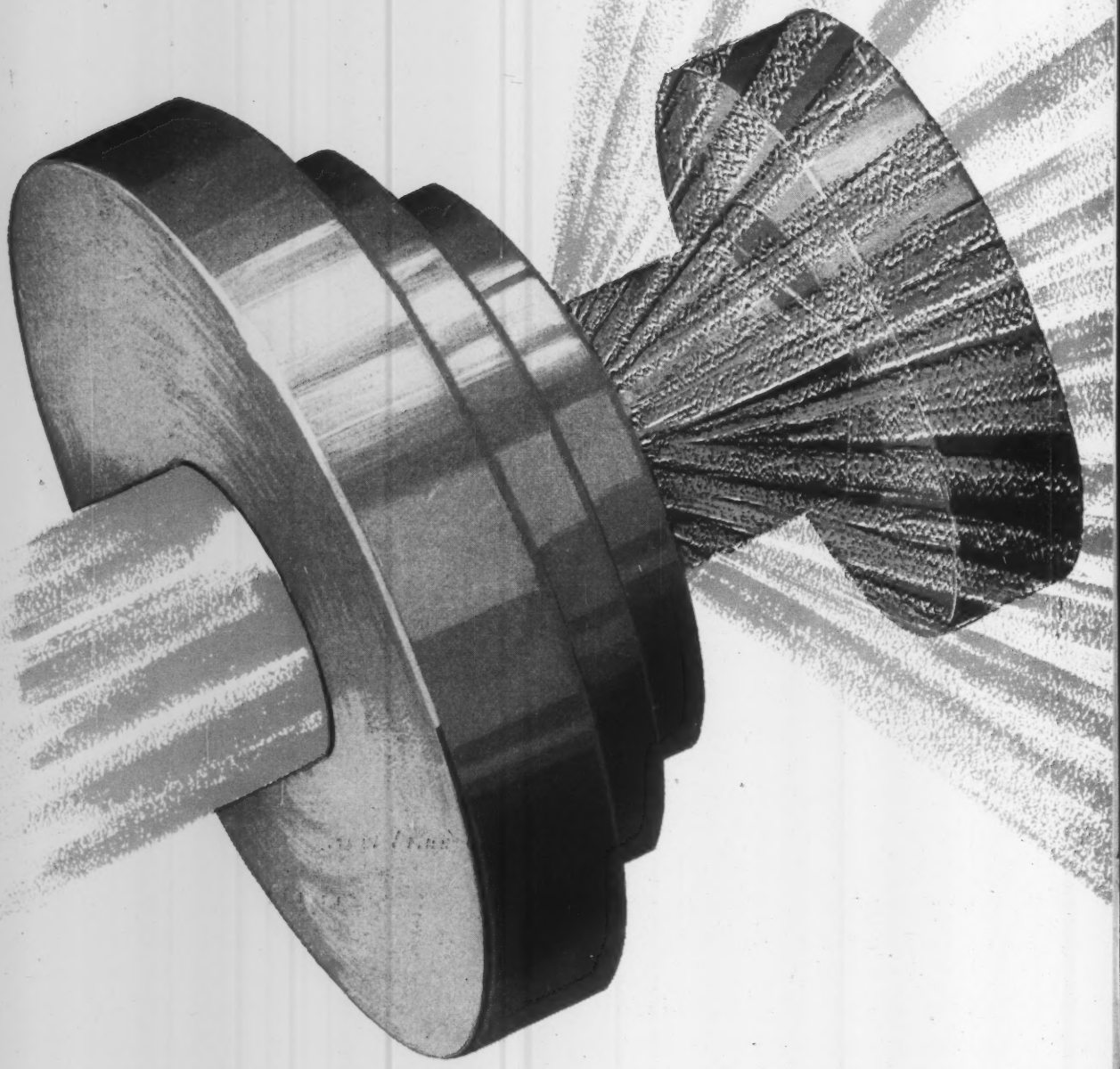
This development is another in the long line of BRANSON engineering break-throughs, which enables industry to solve its problems by means of ultrasonic testing. The next time you have a testing problem call BRANSON and see how fast BRANSON will find the best solution in the shortest possible time.

SINCE 1946 — THE RESPECTED NAME IN ULTRASONICS

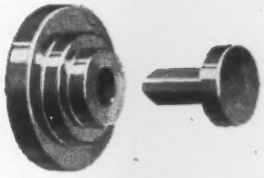
BRANSON INSTRUMENTS, INC.
Ultrasonic Test Division
17 Brown House Road, Stamford, Conn.

For more information, turn to Reader Service card, circle No. 374

FOR THE MACHINERY PART



THAT TAKES THE BEATING



HAYNES Alloys *will do the job!*

Liquids forced at high pressure through restricting valves—of HAYNES STELLITE alloy! That's the modern way by which hundreds of products are homogenized today, to make better dairy, chemical, food, and textile products, to name a few.

HAYNES alloys have been a standard material for homogenizer valves for 25 years. Valves that remain free from roughness, porosity, sharp corners, pits. Valves that retain their dimensions where pressures may reach 15,000 psi, and liquid velocities exceed 30,000 ft. per minute. Valves that keep products clean and free from contamination and give long service despite corrosive and abrasive conditions.

If design and production in your field call for tough metal parts, look into HAYNES alloys. There are more than 15 to choose from including HAYNES STELLITE cobalt-base alloys, HAYNES iron-base alloys, HAYSTELLITE cast tungsten carbide, and HASTELLOY nickel-base alloys. They are available as castings forgings, completely fabricated parts, or as sheet and bar stock. All parts can be furnished machined or ground to specified size and finish.

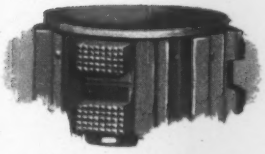
Our engineers will help you pick the right HAYNES alloy to resist practically any condition of wear, heat, or corrosion. For more information write for descriptive literature.

HAYNES
ALLOYS
HAYNES STELLITE COMPANY
Division of
Union Carbide Corporation
Kokomo, Indiana

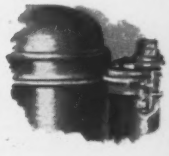
UNION CARBIDE

The terms "Haynes," "Haynes Stellite," "Hastelloy," "Haystellite," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

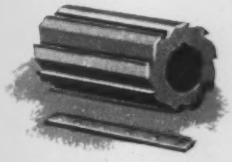
TYPICAL "HAYNES" ALLOY MACHINERY PARTS



Chuck inserts of HAYNES STELLITE alloy last up to 50 days—2 shifts daily—holding heavy pieces during a cut-off operation.

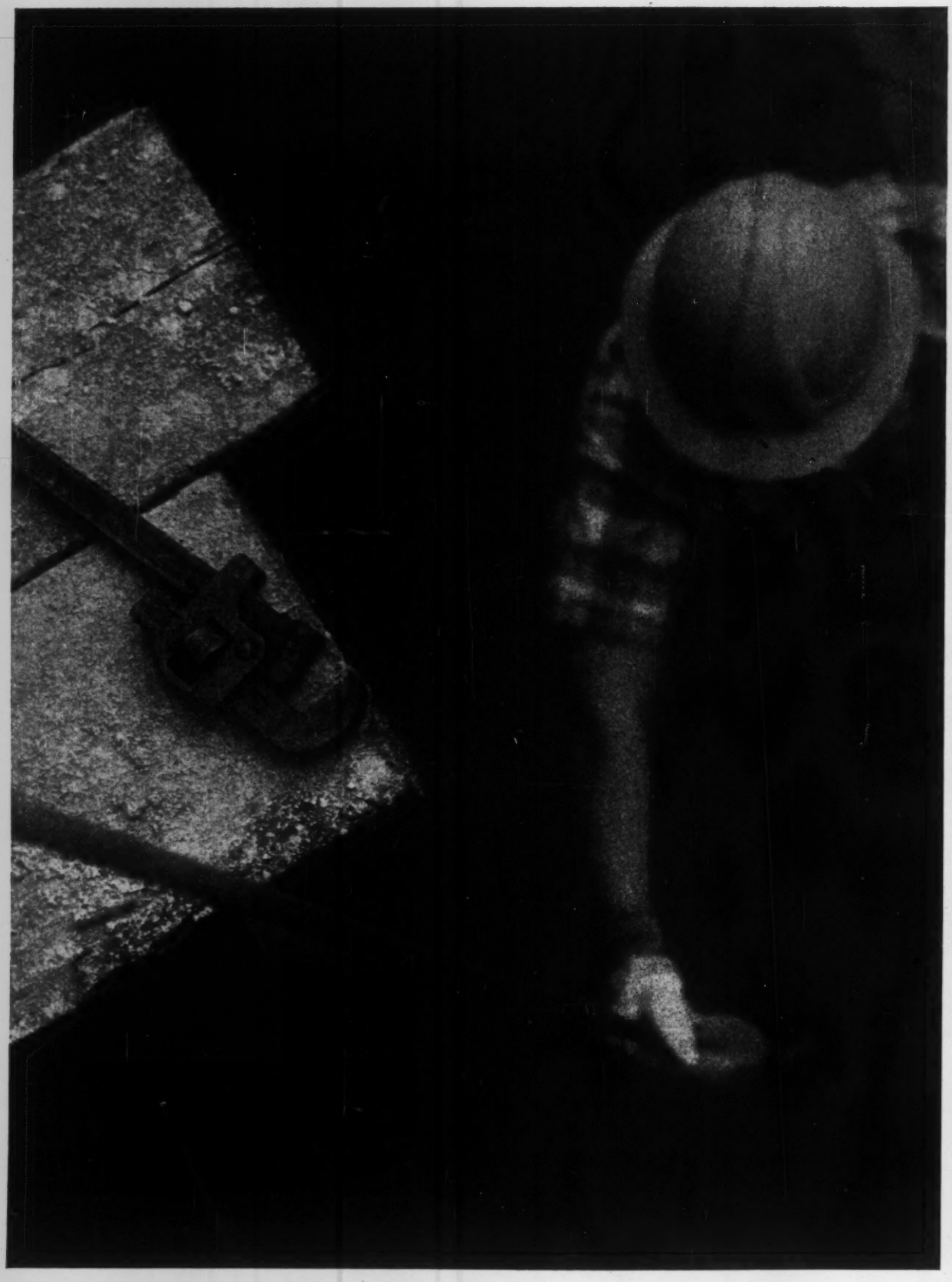


Seam rollers on milk-can machines turn out 2 to 3 times as many cans now that the rollers are made of HAYNES STELLITE alloy.



Cutters and bed knives made of HAYNES STELLITE alloy stay clean and sharp for years while pelletizing extruded polystyrene.

For more information, turn to Reader Service card, circle No. 387



LUSTRAN: T. M. Monsanto Chemical Company

THE SAFEST SAFETY HAT EVER DESIGNED IS MADE FROM NEW, TOUGH MONSANTO LUSTRAN

For the first time a safety hat has been injection molded to pass these Federal, A.S.A., and E.E.I. tests: impact (40-ft. lb.) . . . penetration (less than ⅜" with 16 oz. plumb bob dropped 10 ft.) . . . electrical (30,000 volts). Lustran makes this possible at no increase in manufacturing costs over presently-used materials.

This hat passes these tests because Lustran has a unique combination of superior toughness, rigidity and dielectric strength. One formulation gives 4 times the impact resistance of rubber-modified styrene and 10 times that of general purpose styrene. At zero degrees fahrenheit, a ⅛-inch thick, 24-inch square sheet withstands the shock of a 6-pound ball dropped 48 inches. At 20 degrees below zero, Lustran still maintains its strength and rigidity. Lustran also gives excellent gloss, abrasion and chemical resistance and comes in unlimited colors.

Priced for volume use, starting just pennies a pound above high impact styrene, Lustran is a unique molecular arrangement of styrene, acrylonitrile and butadiene. It has been successfully injection molded into parts weighing as much as 5 pounds and vacuum formed into deep-drawn parts weighing up to 11 pounds. If you are working on a design where the performance-cost balance is critical, write us describing your requirements—or send for Lustran Progress Report and complete test data to Monsanto Chemical Company Plastics Division, Department 1048, Springfield 2, Massachusetts. **MONSANTO** DESIGNER IN **PLASTICS**

Monsanto®

For more information, turn to Reader Service card, circle No. 425

"We needed a special magnetic 78½% nickel alloy in .234" ± .003" diam. rod stock and .042" x 5/16" x 4' strips. We got it from Hamilton."

says Robert Troxell, Relay Engineer, Cook Electric Company, Chicago, Illinois

PRECISION IS OUR PROVINCE. Working to minimum thickness of .00008", widths of 1/32", Hamilton can supply you with foil or strip—rod or wire—of virtually any alloy in production quantities. Our full-scale, completely-integrated facilities and engineering talent in this field permit absolute quality control from melt to finish. Thanks to these capabilities . . . a familiarity with precision work inherited from Hamilton's watchmaking background . . . experience with ultra-thin foils unmatched anywhere in the world . . . we offer you precision metals to meet your exact property and delivery requirements. We guarantee our product. Call us.

For additional information on Hamilton's facilities and capabilities, send for free booklet, "Precision Metallurgical Services." Write Dept. 3112, Metals and Electronics Div., Hamilton Watch Co., Lancaster, Penna.

HAMILTON WATCH COMPANY

Metals and Electronics Division, Lancaster, Penna.

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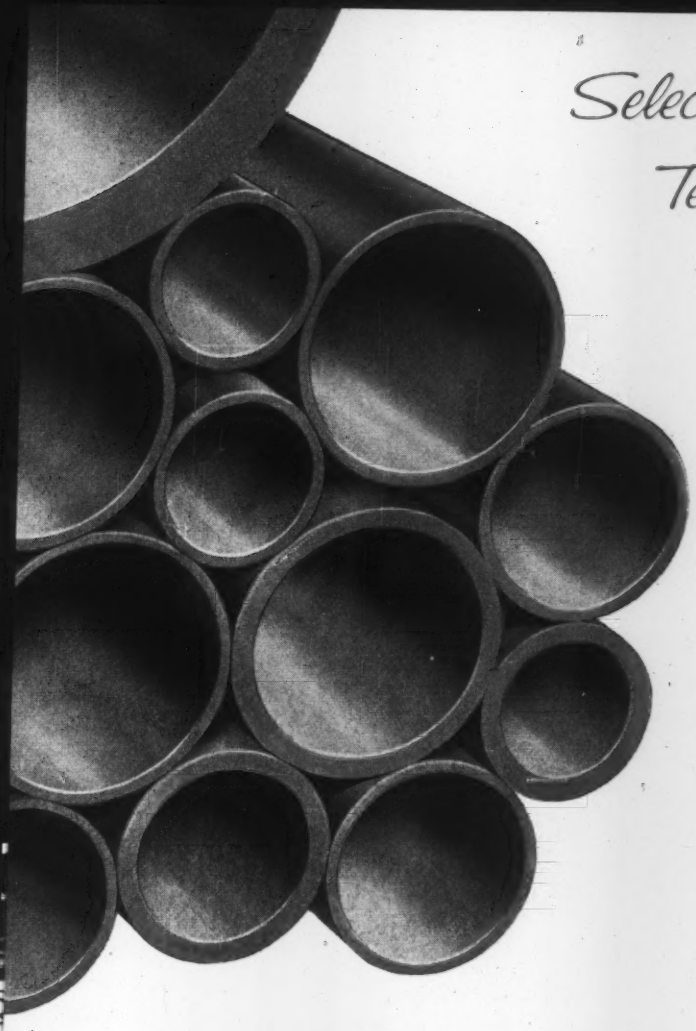
For more information, circle No. 345



Selection of finest raw materials

Testing every step of the way

Inspection to rigid standards

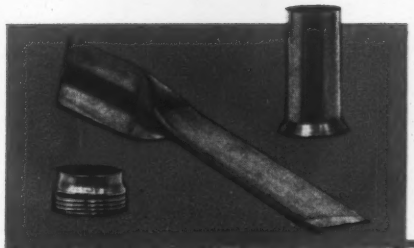
Assure 100% dependability for

OHIO WELDED PRESSURE TUBING

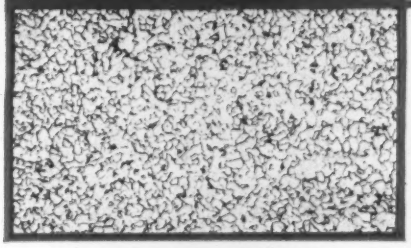
You can be sure — doubly sure — of utmost tubing dependability when you specify Ohio Welded Pressure Tubing — *made by Ohio Seamless*. First, Ohio works to accepted industry standards — ASTM, ASME, and similar Federal and military specifications covering welded pressure tubing. Second, Ohio Welded Pressure Tubing is produced under a *continuous* process of quality control — not just a final test inspection to cull questionable material.

Carefully selected prime raw material is slit, edged, shaped and electric resistance welded on the most versatile and modern equipment in operation. At each and every step of the way Ohio Welded Pressure Tubing is under the scrutiny of Ohio's master tubemakers . . . making control tests at frequent intervals .... testing random samples from each production order far beyond the limits of the usage involved.

For critical pressure piping applications . . . for condensers, heat exchangers, boilers and superheaters — in the range of sizes from ½ to 7½" OD and wall thicknesses from .028 to .375"— mark your prints "*Ohio Custom Made Welded Pressure Tubing*." There is no equivalent.



Photographs show flare, flattening and crush tests performed continuously on every order. Non-destructive tests include air, water, magnetic, eddy current and visual inspection to insure 100% dependability.



Photomicrograph of polished and acid-etched surface shows perfect microstructure of normalized Ohio Welded Pressure Tubing. Weld area running down the center is now indistinguishable and tube has become, in every sense, weldless.

OHIO SEAMLESS TUBE

Division of Copperweld Steel Company

SHELBY • OHIO

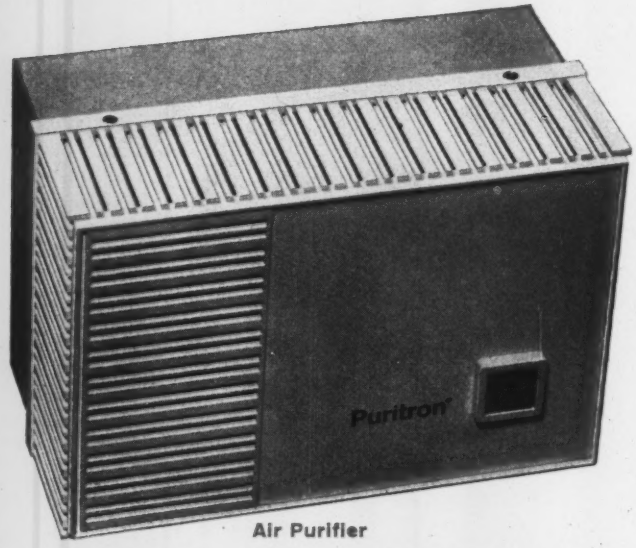
Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

Representatives in principal cities. Check leading directories:
THOMAS', MacRAE'S, CONOVER-MAST, SWEET'S, FRASER'S.

A-6008

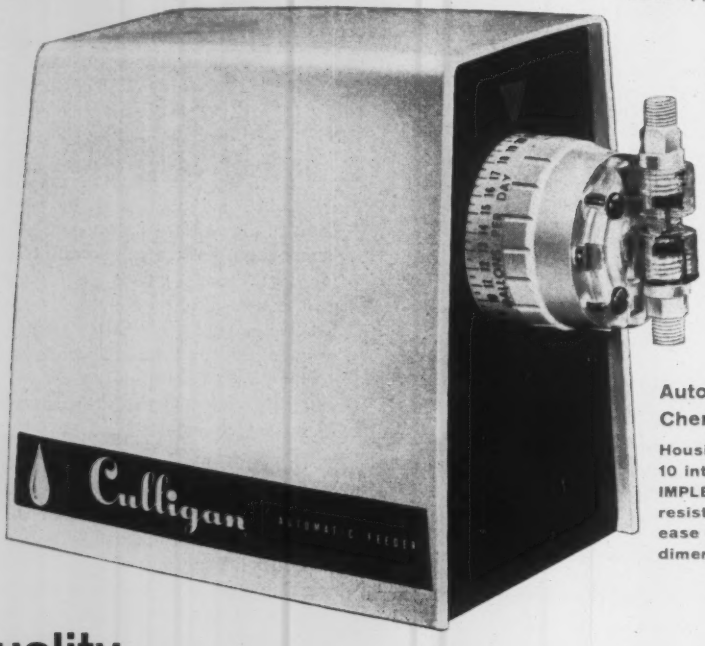
Trading Stamp Dispenser

Housing molded of IMPLEX for impact resistance, high gloss, durability under severe conditions of use.



Air Purifier

Housing molded of IMPLEX for excellent appearance, toughness, color stability, sales appeal.



Automatic Chemical Feeder

Housing, adjustment dial and 10 internal parts molded of IMPLEX for strength, stain resistance, surface hardness, ease of cleaning, dimensional stability.

High quality housings at moderate cost

Housings that match quality appearance with quality performance are just some of the host of parts in many fields that are now being molded of IMPLEX® acrylic plastic. You'll find the specific combination of properties *you* need in one of the five formulations of IMPLEX. Write today for full information on *tough . . . colorful . . . stain-resistant* IMPLEX.

ROHM & HAAS

PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Company of Canada, Ltd., West Hill, Ontario*

IMPLEX

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For more information, circle No. 418

N-S Spring Wire...

The complete line—engineered for reliability—precision drawn stainless steel wire, music spring wire, flat wire and strip, superalloy wire, heavy galvanized wire, plated wire, rocket wire (extra high tensile). Other wire specialties and experienced National-Standard engineering service help meet your special requirements.

NS
NATIONAL-STANDARD COMPANY

NATIONAL-STANDARD COMPANY
Niles, Michigan

Introducing a new type of "Armalon"

new "Armalon" FEP-fluorocarbon resin coated glass fabrics

After extensive development and testing, Du Pont now can offer "Armalon" FEP-fluorocarbon resin coated glass fabrics. The FEP resin has unique properties that enable this new "Armalon" to find applications in areas not appropriate to our regular TFE line of "Armalon".

Outstanding advantages of new "Armalon" FEP

- Uniform porosity resistance
- New lower melt point for easier lamination
- Good heat resistance
- Extreme toughness
- Abrasion resistance
- Excellent electrical properties over a wide range of temperatures and frequencies
- High degree of chemical inertness
- Smooth, anti-adhesive surface with anti-stick qualities

Comparison of properties of new "Armalon" FEP and "Armalon" TFE

PROPERTIES	FEP 503-108	TFE 403-108	FEP 505-112	TFE 405-112	FEP 506A-116	TFE 406A-116	FEP 510-128	TFE 410-128
Breaking Strength	65 x 40	45 x 35	130 x 65	75 x 60	160 x 160	90 x 90	260 x 220	200 x 175
Tear (Elmendorf)	16 x 6	10 x 5	21 x 8	15 x 10	13 x 14	12 x 12	49 x 39	40 x 40
Moisture Absorption	.23	.64	.18	.68	.30	.32	.276	.10
Burst	150	25	200	25	380	100	410	100

Characteristics of new "Armalon" FEP

The "Teflon" FEP-fluorocarbon resin coating on "Armalon" FEP gives this new material several outstanding properties (not provided by "Armalon" TFE). For example, the FEP resin has a lower melt point (545°F. to 563°F.) than the TFE resin. This recommends the use of "Armalon" FEP as a coating on glass fabrics that are to be heat-sealed. In addition, FEP dispersion-coated glass fabrics have lower permeability, greater breaking strength and lower moisture absorption than "Armalon" TFE.

You may want a material that doesn't crack when creased under moderate pressure. "Armalon" FEP won't. There is no known solvent for its FEP resin coating, and it is unaffected by aqua regia and all known chemicals except molten alkali metals. Corrosive materials and atmospheric conditions have no effect on it.

"Armalon" FEP remains flexible after long exposure to high temperatures, and pliable at temperatures lower than -100°F. Of particular significance are the improvements in burst strength and moisture absorption in the higher resin, lower glass qualities (see Qualities 503-108 and 505-112).

Suggested uses for new "Armalon" FEP

An important use for new "Armalon" FEP is in the wrapping and fusing operations for pipe covering, roll covering and chemically resistant containers. We also recommend these new materials for gaskets and specialized diaphragms, because of their satisfactory levels of uniform porosity resistance.

Industries that should find new "Armalon" FEP useful are aircraft, chemical, food processing, packaging, paper, plastics, printing, rubber, textile and various other industries.

FOR EXAMPLE: Conveyor belts used in baking, candy and food industries where sanitation and ease of release are important—Non-sticking covers for heat-sealing bars on packaging equipment—Diaphragms for regulators and control instruments where heat and chemical resistance are required. These are a few suggested uses for new "Armalon" FEP—there are many, many more. What application does this new product suggest to you?

For complete information on new "Armalon" FEP, its application and uses, write: E. I. du Pont de Nemours & Co. (Inc.), Fabric Sales, Wilmington 98, Delaware.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

"ARMALON" COATED GLASS FABRICS

"Armalon" is Du Pont's trademark for its FEP and TFE fluorocarbon resin-coated fabrics and laminates.

For more information, turn to Reader Service card, circle No. 376

Ameripol Rubber pins costs to the mat

In the highly competitive automotive floor mat business, Anchor Industries, Inc., Cleveland, Ohio, has solved the problem of producing a durable, attractive product at the lowest possible cost. Since switching to an Ameripol Rubber polymer, Anchor has reduced material costs over 10%. This major savings was made possible by Goodrich-Gulf's development of high oil-extended synthetic rubbers. You can take advantage of such continual improvements in synthetic rubber when you do business with Goodrich-Gulf. We produce the broadest range of rubber polymers, and offer complete technical service to help you meet exacting requirements. Contact Goodrich-Gulf Chemicals, Inc., 1717 East 9th Street, Cleveland 14, Ohio.

Ameripol
THE PREFERRED RUBBER

Goodrich-Gulf Chemicals, Inc.
WORLD'S LARGEST SOURCE OF SYNTHETIC RUBBER

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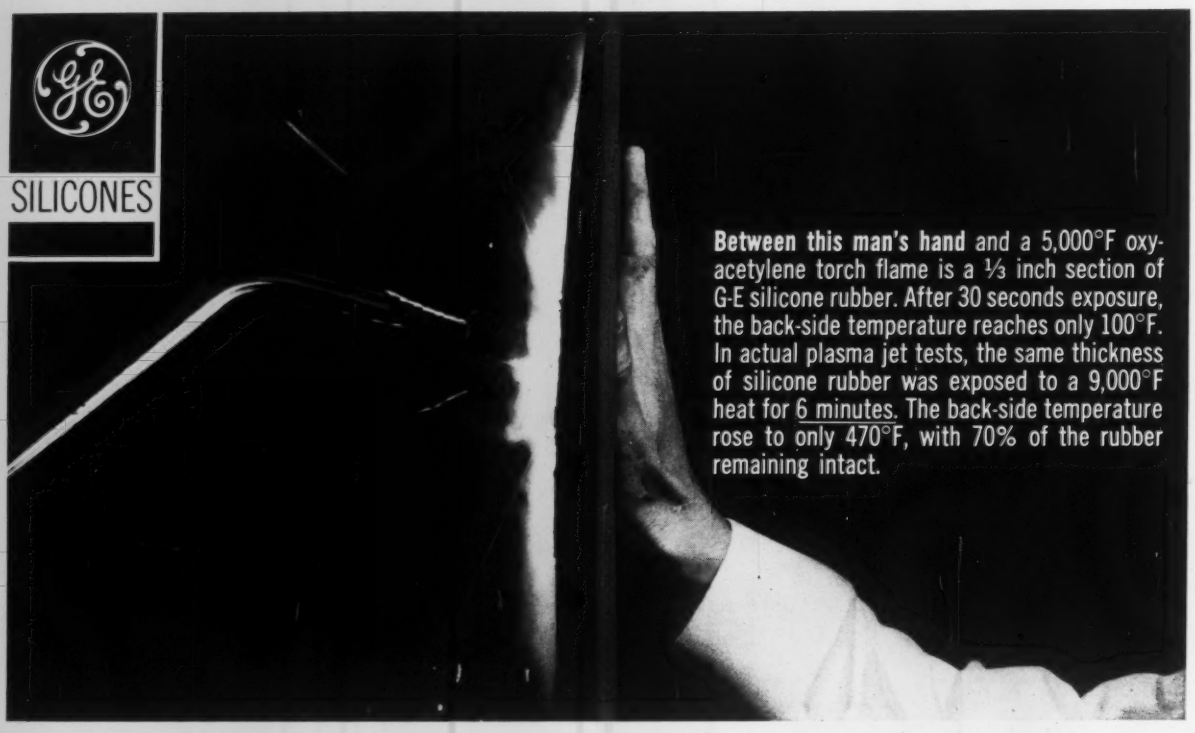
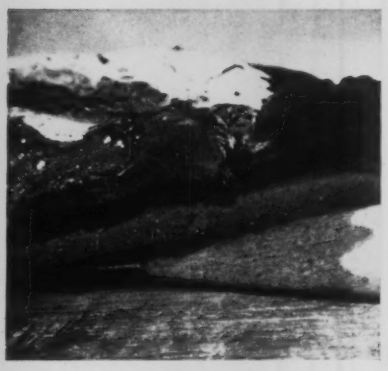
SILICONES



Between this man's hand and a 5,000°F oxy-acetylene torch flame is a ⅓ inch section of G-E silicone rubber. After 30 seconds exposure, the back-side temperature reaches only 100°F. In actual plasma jet tests, the same thickness of silicone rubber was exposed to a 9,000°F heat for 6 minutes. The back-side temperature rose to only 470°F, with 70% of the rubber remaining intact.

Thermal barrier against 5000°F flame

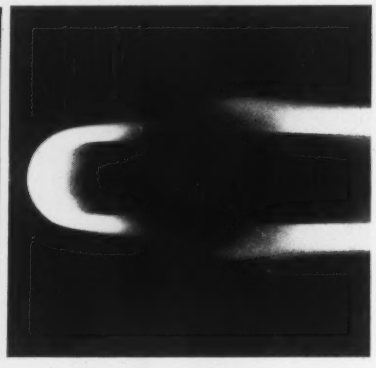
GENERAL ELECTRIC SILICONE RUBBER



RESULTS OF PLASMA JET TESTS AT 9,000°F

Flight Simulation
Vel. = 17,000 ft./sec.
Alt. = 250,000 ft.

Exposure time at 9,000°F	Back-side temperature of ⅓ inch section of G-E silicone rubber
30 seconds	100°F
2 minutes	210°F
3 minutes	300°F
4 minutes	375°F
5 minutes	430°F
6 minutes	470°F



The surface of the tested rubber section forms a hard, carbonaceous crust, while the underside remains flexible and undamaged. Preliminary tests showed the effective heat of ablation to be eight times better than presently used plastics, with one-seventh the rate of ablation and one-fourth the weight loss. Here is an excellent ablative covering with low thermal conductivity.

The above chart shows how the high thermal insulation of G-E silicone rubber is maintained during exposure to 9,000°F heat. It is also useful in mechanical and electrical applications at temperatures from —150°F to 600°F, where it remains resilient and flexible. It also maintains its excellent physical and electrical properties over this wide temperature range for extended periods.

Continued high temperature testing goes on at General Electric's Missile and Space Vehicle Department in Philadelphia. Shown above is a typical specimen undergoing plasma jet testing in an electric arc heated supersonic wind tunnel. Continuous testing like this will develop new data on the thermal and ablative uses of G-E silicone rubber.

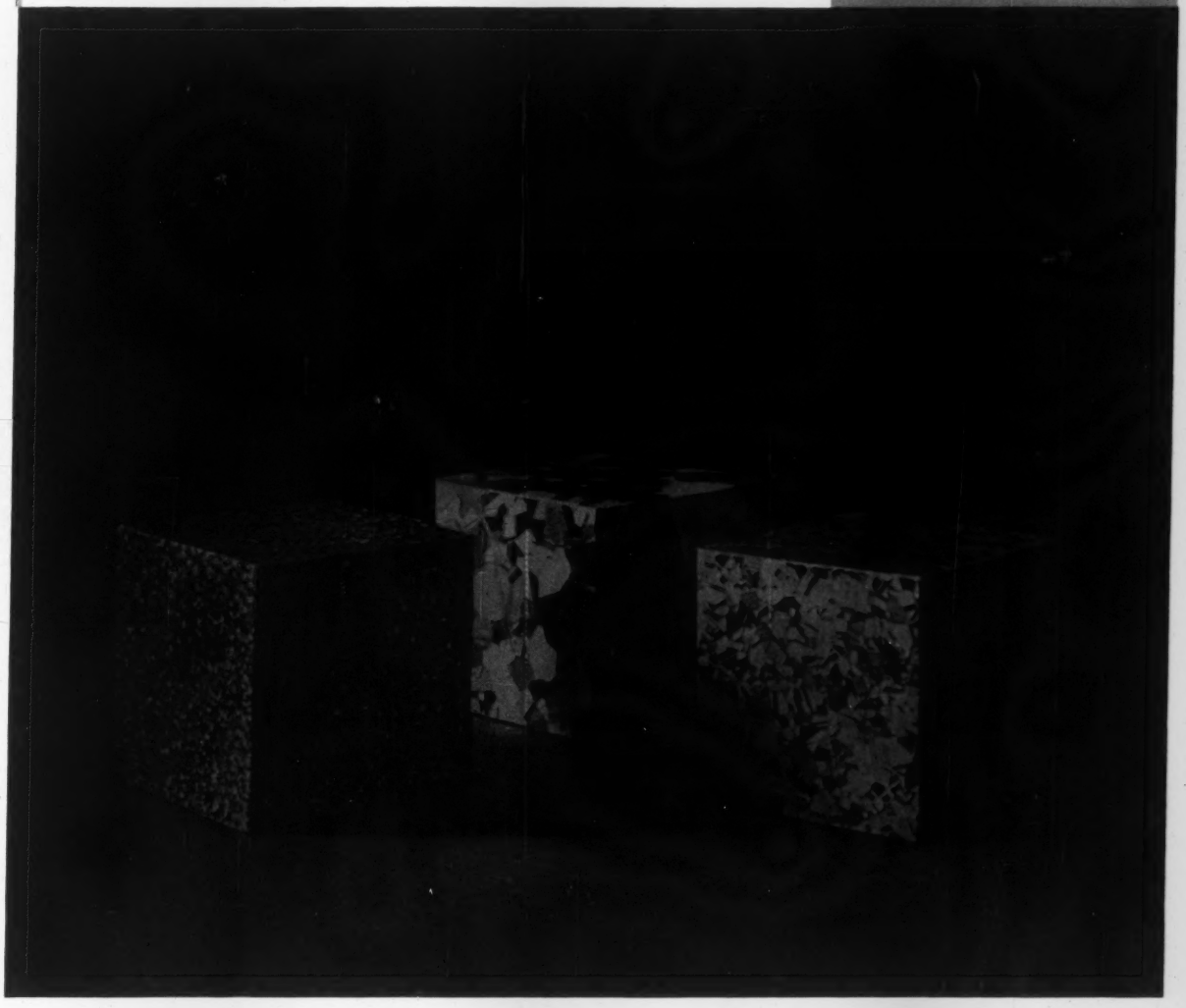
To learn more about G-E silicone rubber, and its uses as a thermal and ablative material, write: General Electric Company, Silicone Products Dept., Section B1261, Waterford, New York.

GENERAL ELECTRIC

For more information, turn to Reader Service card circle No. 373

Copper Alloy Bulletin

BRIDGEPORT BRASS COMPANY



Are you overlooking the 4TH dimension in design?

We're referring to "grain size". Our experience in supplying copper and brass alloys for a wide variety of applications tells us that all too often metals are specified with little regard to grain size.

This can be a serious oversight in engineering design.

Grain size affects the strength, hardness and elongation of copper-base alloys. Formability and surface finish, too. Ever wonder why, after a severe forming operation, a metal part exhibited an "orange peel" surface? Grain size was too large. A finer grain size would have saved many hours of polishing time.

Selecting the best grain size for a metal part involves consideration of production techniques, surface finish requirements and strength requirements. No one grain size can successfully satisfy all the various combinations of these three factors.

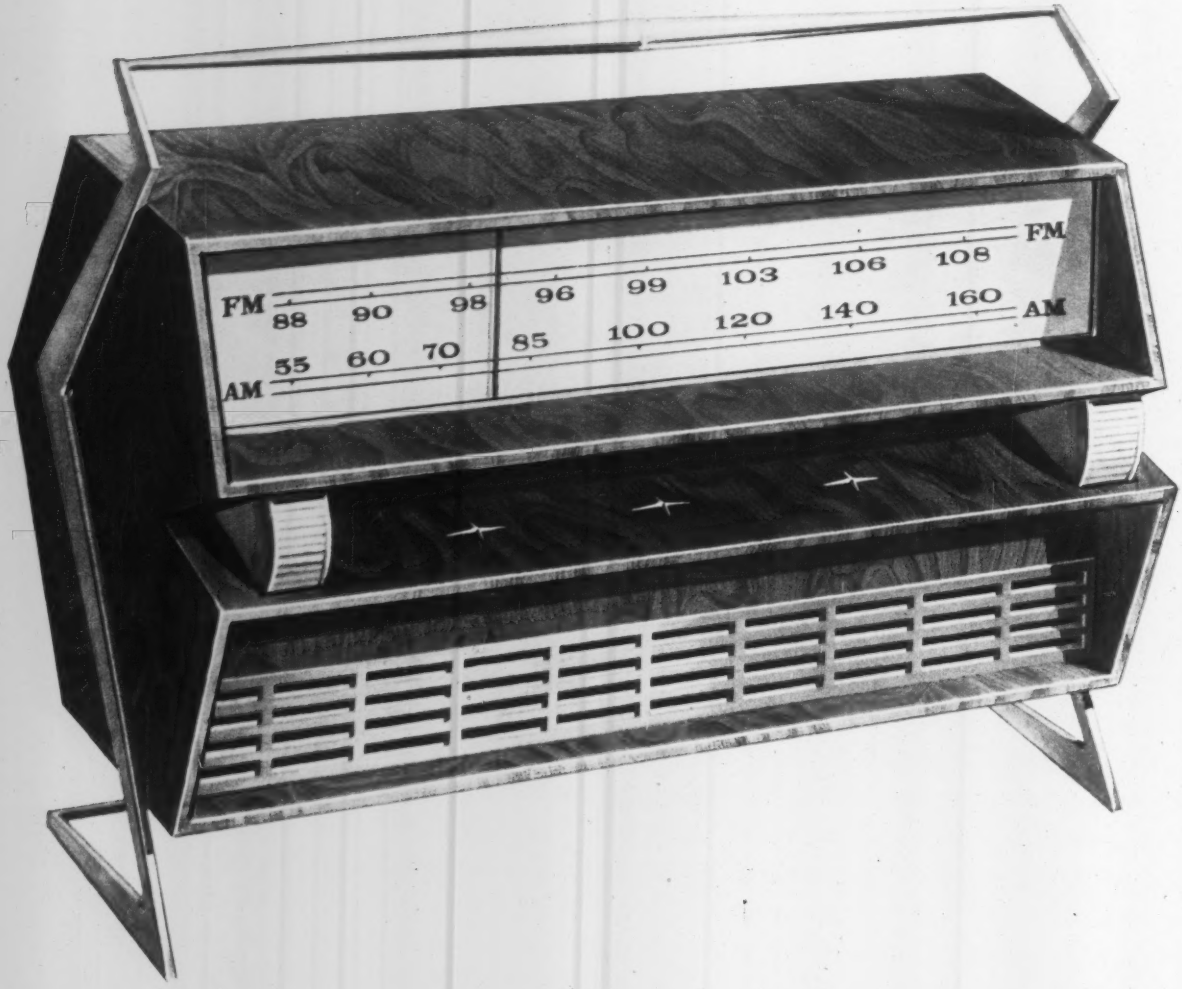
To help you determine the correct grain size for your product, Bridgeport maintains a Technical Service Department staffed with skilled specialists in metallurgy and production processes.

For detailed information on how grain size affects product design, send for a copy of our booklet, "The Fourth Dimension of Brass." Write to Bridgeport Brass Company, Bridgeport 2, Connecticut.

For more information, turn to Reader Service card, circle No. 431

FROSTWOOD

. . . molded articles of Pelaspan offer



An exciting new dimension of *texture* is captured in *Frostwood** molded articles . . . produced by injection molding Pelaspan® expandable polystyrene beads. *Frostwood* molded articles have a distinctive swirled texture reminiscent of rich, fine wood grain. Because the wood grain pattern never repeats itself exactly, every article becomes an original.

*TRADEMARK

a foam core with a hard, textured skin!

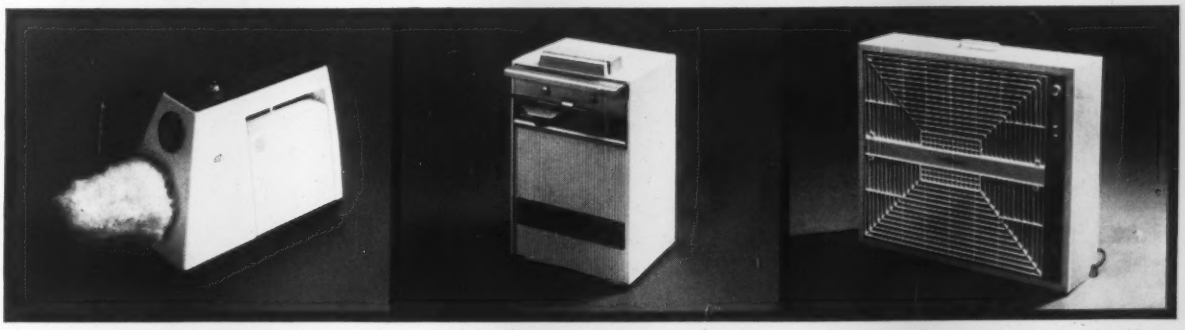
The ability to create *Frostwood* molded articles offers designers a vast, untapped potential for products of every description . . . for housewares, such as carafes and thermal tumblers . . . furniture parts, such as chair backs . . . appliance shells . . . and for other design applications where appearance is a major consideration.

Frostwood molded articles are made by injection molding Pelaspan expandable polystyrene beads. A special technique produces molded articles having a lightweight core of foamed polystyrene with durable, shock-resistant, textured surface. *Frostwood* articles offer high thermal insulating efficiency, plus unique one-of-a-kind texturing which gives *Frostwood* molded products eye-catching, sales-making beauty.

Frostwood molded articles can be produced from Pelaspan by a special technique, on most standard injection molding equipment. There are few limitations on shape and contour. Here are almost unlimited new product design possibilities!

Dow Plastics Technical Service Engineers will help you adapt this material to your design problems. Write us today in Midland, C/O Plastics Sales Department 1722CD12.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan



ELECTRIC SHOE BUFFER by Royal Master. Styron® plastic offers wide color range, high impact strength and light weight to this unique product.

ELECTRIC CAN OPENER by Westinghouse. Colorful housing of Styron plastic combines excellent moldability with food and chemical resistance.

EXHAUST FAN by Berns Air King. Grille of high-impact Styron plastic resists shock and vibration. Grease and stains wipe clean in a jiffy.

For more information, turn to Reader Service card, circle No. 356

For more information, circle No. 421

NEW ADDITIONS

to the Allegheny Ludlum High Strength and High Temperature Steels

AL REFERENCE DATA

Compiled by
ALLEGHENY LUDLUM STEEL CORPORATION
Oliver Building • Pittsburgh 22, Pennsylvania

	Alloy Name	NOMINAL CHEMICAL COMPOSITION											
		C	Mn	Cr	Ni	Co	Mo	W	Ti	Al	B	Fe	Others
Fe-Base	19-9DL	.30	1.0	19	9	...	1.4	1.3	.3	...	...	66	.4 Cb
	19-9DX	.30	1.0	19	9	...	1.6	1.3	.6	...	...	66	.....
	AF-71	.30	18	12.5	...	...	3	...	...	...	.2	73	.2N, .9V
	A-286	.05	1.4	15	26	...	1.25	...	2.2	.2	.003	54	.3 V
	Discaloy	.05	.6	13	26	...	3	...	2	.2	...	54	.....
	G-192	.60	8.5	22	...	...	...	...	...	...	...	69	.35 N
	V-57	.06	.25	15	26	...	1.3	...	.3	.2	.008	54	.2 V
Fe-Ni	D-979	.05	.6	15	45	...	4	4	3	1	.01	27	.....
	AL 901	.05	.25	13	43	...	6	...	2.9	.2	.015	35	.03 Zr
Ni-Base	Waspaloy	.05	.3	19	56	14	4	...	3.0	1.3	.005	1	.....
	M-252	.15	.5	19	55	10	10	...	2.5	1	.005	2	.....
	R41	.10	.3	19	53	11	10	...	3.2	1.6	.005	2	.....
Co-Cr-Fe-Ni	S-590	.43	1.2	20	20	20	4	4	...	...	...	29	4 Cb
	N-155	.15	1.5	21	20	20	3	2.5	...	...	...	32	1 Cb
Co-Base	S-816	.40	1.2	20	20	44	.4	4	...	...	...	3	4 Cb
	V-36	.30	1	25	20	42	4	2	...	...	...	3	2 Cb
	L-605	.15	1.5	20	10	53	...	15	...	...	...	...	.....

A number of the names listed above are tradenames of companies other than Allegheny Ludlum Steel Corporation.

AL REFERENCE DATA

Compiled by
ALLEGHENY LUDLUM STEEL CORPORATION
Oliver Building • Pittsburgh 22, Pennsylvania

	Alloy Name	Density lb/in.³	100-Hr. Rupture Strength at (X 1000 Psi)				Short Time Properties					
			1200F	1350F	1500F	1600F	Room Temperature			1200 F		
							TS (X 1000 Psi)	.2YS	Elong. %	TS (X 1000 Psi)	.2YS	Elong. %
Fe-Base	19-9DL	.287	52	28	17	...	118	69	55	75	37	33
	19-9DX	.287	52	28	17	...	118	69	55	75	37	33
	AF-71	.280	69	40	22	...	150	110	30	90	77	43
	A-286	.286	63	35	15	...	152	110	25	115	87	25
	Discaloy	.288	55	32	15	...	147	92	20	100	77	18
	G-192	.278	42	27	15	...	148	85	55	92	37	15
	V-57	.286	75	40	15	...	172	119	24	129	108	22
Fe-Ni	D-979	.296	94	63	35	21	200	143	18	157	123	17
	AL 901	.294	90	60	20	...	175	125	15	145	110	20
Ni-Base	Waspaloy	.294	98	65	39	24	185	130	28	160	120	22
	M-252	.298	95	62	35	20	180	122	16	155	110	17
	R 41	.296	100	67	44	28	200	150	15	160	130	10
Co-Cr-Fe-Ni	S-590	.301	50	32	22	13	140	75	20	97	70	25
	N-155	.297	50	31	18	12	119	58	40	80	43	55
Co-Base	S-816	.313	60	38	25	16	140	72	35	115	55	27
	V-36	.303	64	35	25	18	145	67	55	95	40	28
	L-605	.330	70	43	24	15	150	70	50	98	48	28

Properties listed above are typical, and should not be used as specification minima.

Mar-Aging Steels...with yields over 250,000 psi PLUS toughness!

Looking for "special" properties even in the special steels? Take a look at the Mar-Aging Steels, a brand new group of high alloy, precipitation-hardening steels offering unmatched toughness and the strength of the best contemporary steels. Here are a few interesting properties ... yield strengths exceeding 250,000 psi ... notched tensile strengths over 400,000 psi ... and the ability to maintain ductile properties below −80 F.

NOMINAL COMPOSITION OF MAR-AGING STEELS

	C	Ni	Co	Mo	Ti	Al	Cb
AL 25 Ni (250)	.01	25	..	..	1.4	.2	.5
AL 20 Ni (250)	.01	20	..	..	1.4	.2	.5
AL 18 Ni Co Mo (250)	.01	18	7	5	.4	.1	..
AL 18 Ni Co Mo (300)	.01	18	9	5	.6	.1	..

Discovered by International Nickel Company, developed and being produced by Allegheny Ludlum, the Mar-Aging steels achieve their high strength by means of an extremely simple heat treatment. Remarkably resistant to crack propagation, the Mar-Aging Steels are easily machinable, easy to weld, and possess unusually low work-hardening characteristics. Available in all product forms, the Mar-Aging Steels may be air melted, or vacuum melted for maximum notch toughness and transverse ductility.

TYPICAL MECHANICAL PROPERTIES OF MAR-AGING STEELS

PRODUCTS	.2 YS (X 1000 psi)	UTS (X 1000 psi)	Elong. %	RA %	Notch TS / Smooth TS
BARS (Heat treated)					
AL 25 Ni (250)	250	265	12	50	1.1
AL 20 Ni (250)	250	265	12	55	1.3
AL 18 Ni Co Mo (250)	250	265	10	50	1.5
AL 18 Ni Co Mo (300)	300	305	12	55	1.4
SHEETS (Cold rolled and aged)					
AL 25 Ni (250)	250	270	5	..	.7
AL 20 Ni (250)	260	270	4	..	.7
AL 18 Ni Co Mo (250)	285	290	4	..	.9
AL 18 Ni Co Mo (300)	300	310	3	..	.8

Together with A-L's family of famous stainless steels (all grades—all mill forms), low alloy-high strength steels, tool steels, bearing steels, and high temperature steels and alloys, the Mar-Aging Steels make the Allegheny Ludlum product line one of the most comprehensive offered to the aircraft and missile industries. And to assist in applying this family of steels, A-L offers customer contact service at any level in your organization, including in-plant teamwork with your specialists on your problems. Add the support of the A-L research organization, and technical literature written in *your* language, and you have the famous Allegheny Ludlum service.

3803

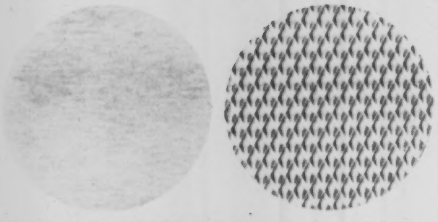
ALLEGHENY LUDLUM

NEW A-L LITERATURE

A new series of technical booklets on A-L High Temperature Alloys is yours for the asking. Each is packed with data to assist design engineers and procurement specialists in selecting materials for any high strength-high temperature application.

And be sure to get your request in early for the new Data Sheet on Mar-Aging Steels. Contact your local A-L Representative, today. Or write: Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address: Dept. MID 6.

If you made aluminum crust for apple pie which would be best to use?



PLAIN OR PATTERNED? To help you decide, send for free sample kit of Fairmont embossed pattern sheets now putting new sales appeal into everything from awnings to truck bodies. Fairmont offers truly wide range of alloys, tempers, gauges, finishes. Write Dept. 25-L. Fairmont Aluminum Company, Fairmont, West Virginia.

THE RIGHT ANSWER TO ALUMINUM BUYING PROBLEMS depends upon right materials utilization.

For instance—many an item slated for plain sheet (because this *seems* to be most economical) can really be fabricated on a more practical level with one of Fairmont's embossed patterns. A lighter gauge embossed material provides dimensional stability, increases yield on a cost-per-pound basis, improves product eye-appeal.

MORAL: before final buying decisions are made, consult with a Fairmont field engineer. His mature and varied experience among aluminum fabricators makes him a whiz at application ideas that help you buy profitably. And he's backed by the aluminum source, according to a recent survey, that rates first for fulfilling promises and commitments.

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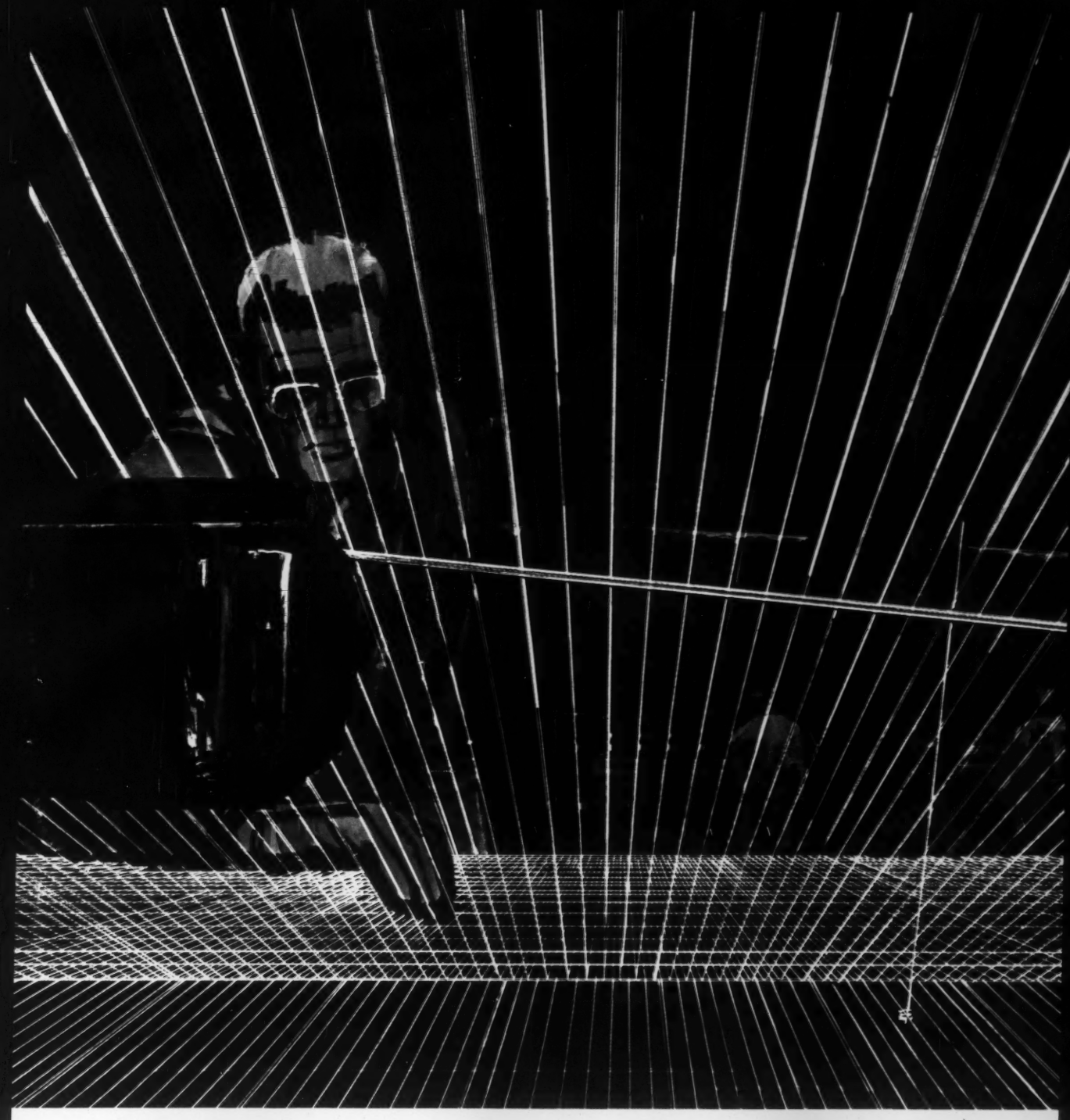

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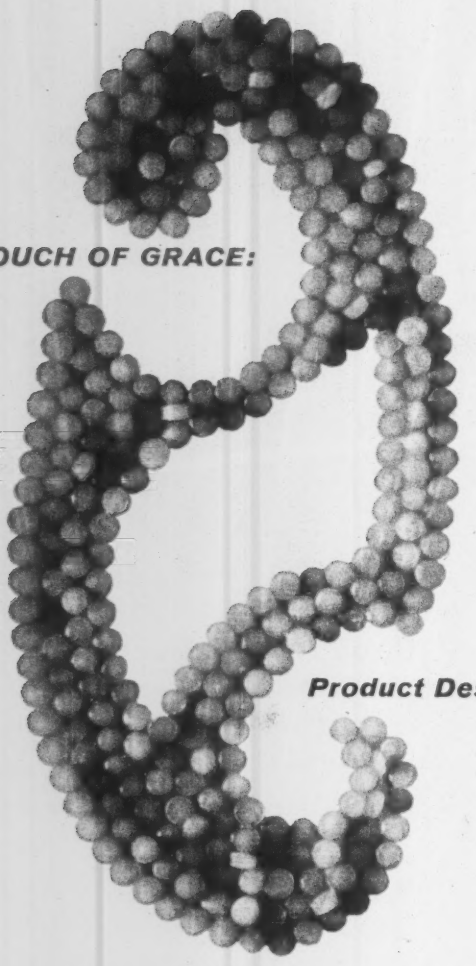

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PLASTICS		
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Acrylic compound has high impact strength	148	620
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OTHER NONMETALLICS		
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Industrial Ceramics. Du-Co Ceramics Co., 16 pp, illus. Information on the services and facilities available for the production of steatite, forsterite, cordierite, zircon porcelain, mullite, wollastonite, alumina, etc. Includes information on production and fabrication of typical extruded and pressed parts, and a chart giving physical, mechanical, chemical and electrical properties of ceramic. **116**

Elastomer-Coated Fabrics. E. I. du Pont de Nemours & Co., Inc., Fabrics Div., Fabrics & Finishes Dept., 12 pp, illus. Uses, properties, sizes and specifications of synthetic elastomer-coated fabrics. **117**

Leather Packings. Garlock Inc., 12 pp, illus., No. AD-186. Advantages, characteristics, properties, tanning information, size ranges, typical uses, and other information on leather packings, for hydraulic pneumatic service. **118**

Graphite. Graphite Specialties Corp., 4 pp, No. GS-101-1. Chemical and physical properties of an impervious graphite for high temperature parts. **119**

Dielectric Coolant. Minnesota Mining & Mfg. Co., Chemical Div., 6 pp, illus., No. Y-ILL (8015) J-O. Heat transfer, electrical and surface properties; high temperature and chemical stability; radiation resistance; typical

uses; and other information on a line of dielectric coolants. **120**

Moldproof Paper. Mosinee Paper Mills Co., 2 pp, No. 101. Properties and uses of a mold resistant paper. **121**

Insulating Materials. Mycalex Corp. of America, 4 pp. Chart compares electrical, thermal, and physical properties of commonly used plastic and ceramic insulating materials with various formulations of ceramoplastics and glass-bonded mica. Also included is a list of temperature limits for 88 different materials and a table of thermal expansion coefficients for 57 widely used insert metals and insulating materials. **122**

Carbon and Graphite. Ohio Carbon Co., 8 pp, illus., No. 1164A. Composition, characteristics, properties and applications of carbon and graphite. **123**

Carbon-Graphite. Pure Carbon Co., Inc., 12 pp, illus., No. 55. Catalog on carbon-graphite for mechanical applications. **124**

Carbon and Graphite. Stackpole Carbon Co., Carbon Products Div., 54 pp, illus., No. 40 C. Properties, and mechanical, chemical, electrical and refractory applications of carbon and graphite products. **125**

Heat Reflection. Thermo-Chem Corp., 4 pp. High and low temperature barrier capabilities, strength, abrasion resistance and other information on a process capable of imparting heat reflection properties to ordinary textiles, fabrics, paper, felt, rubber, plastics and leather. **126**

Carbon-Graphite Materials. National Carbon Co., Div. of Union Carbide Corp., 8 pp, illus., No. S-5425. Descriptions of 18 grades of carbon, graphite, and carbon-graphite materials for bearings, bushings, and seals. Includes advantages, characteristics, and properties for each grade. **127**

Felt and Its Uses. Western Felt Works, 38 pp illus., No. 562 A-F. General information on what felt is, how it is manufactured, and where it is used. Includes properties and specifications, standard test methods, wicking and lubrication, design and application of felt seals, special treatments, filtration, and machine mountings. **128**

FINISHES
and Cleaning & Finishing

Chromate Conversion Coatings. Allied Research Products, Inc., 28 pp, illus. Discusses chromate conversion coatings for zinc, cadmium, copper, brass, bronze, aluminum, magnesium and silver. **129**

Coatings for Metal. Amchem Products, Inc., 8 pp, No. 1413D. Method of application, purpose of coating and typical applications of a line of chemical conversion coatings for aluminum, copper and copper alloys, iron and steel, zirconium, and other metals. **130**

Ultrasonic Cleaning. Branson Instruments, Inc., 14 pp, No. S-700. Physical properties, suggested applications, working temperatures, procedures, and other information on several chemicals used in ultrasonic cleaning. **131**

Painting Machine. Conforming Matrix Corp., 1 p, illus. Automatic painting machine for spray finishing of cylindrical and rectangular parts. **132**

Nickel Alloy Coatings. General American Transportation Corp., Kanigen Div., 12 pp, illus. Physical, chemical, electrical, mechanical and frictional properties; abrasion resistance; salt spray resistance; adhesion; typical applications; plating methods; and corrosion resistance of electroless nickel alloy coatings. **133**

Chromate Coating. R. O. Hull & Co., Inc., 1 p. General information on a chromate treatment for aluminum and its alloys. **134**

Coatings for Mirrors. Libby-Owens-Ford Glass Co., Liberty Mirror Div., 32 pp. Reflectivity, adherence, hardness, durability, water resistance, effect of temperature and other information on a line of coatings for mirrors. **135**

Fusion Coatings. Michigan Chrome & Chemical Co., Chemical Div., 6 pp, illus. Information on small particle size plastics powders for use in fluidized bed coatings. Information also on equipment for fluidized bed coating. **136**

Silicone Coating. Midland Industrial Finishes Co., 4 pp, illus. Properties, application data, corrosion resistance and uses of a silicone coating. **137**

Pressure Blasting. Norton Co., Refractories Div., 16 pp, illus. Describes the areas of application for pressure blasting and the various media used. Emphasis is on the proper selection and use of aluminum oxide and silicone carbide abrasives. **138**

Gold Electroplate Thickness. Sel-Rex Corp., Precious Metals Div., 5 pp, illus. Latest techniques for controlling and measuring thickness and hardness of precious metal electroplates, with particular emphasis on gold. **139**

High Temperature Coatings. Swedlow Inc., Western Contracts Dept., 4 pp, illus., No. 500-61. Advantages, characteristics, uses, heat resistance, and other information on several high temperature coatings for applications requiring exposure to over 5000 F. **140**

Vinyl Coatings. U. S. Stoneware Co., Plastics & Synthetics Div., No. 187F-1. Chemical and moisture resistance, adhesive properties and application data for a vinyl coating that is applied by hot spraying. **141**

JOINING & FASTENING

High Strength Adhesive. Eastman Chemical Products, Inc., Chemical Div., 12 pp, illus., No. R-103. Application data, physical properties, heat and chemical resistance, and tensile properties of bonds made with a high strength adhesive called 910. **142**

Brazing Stainless Steel. Handy & Harman, 4 pp, illus., No. 85. Advantages, characteristics, methods, typical applications, and other information on brazing stainless steel. **143**

Silver Brazing Alloy Preforms. Lucas-Milhaupt Engineering Co., 20 pp, illus. Advantages, characteristics, uses, specifications, design information, typical applications, and other data on silver brazing alloy preforms. **144**

Adhesives, Coatings, Sealers. Minnesota Mining & Mfg. Co., Adhesives, Coatings & Sealers Div., 12 pp, No. A-ZBD-102-JR. Series of fold-out tables give uses, characteristics, and general properties of over 170 different adhesives, coatings and sealers. **145**

Pressure-Sensitive Tapes. Permacel Inc., 12 pp, illus. Characteristics, advantages, uses, and other information on a line of pressure-sensitive and heat sealing cloth tapes. **146**

Set Screws. Set Screw & Mfg. Co., 28 pp, illus., No. 21. Information on self-tapping and stainless steel set screws. **147**

Methods for Joining Metals. Linde Co., Div. of Union Carbide Corp., 36 pp, illus. Discusses various welding techniques for joining ferrous and nonferrous metal parts such as tanks, railroad cars, condensers and bulldozers. **148**

Hot Melt Adhesive. B. B. Chemical Co., Div. of United Shoe Machinery Corp. Series of bulletins provide technical information and performance data on seven hot melt adhesives. Includes data on bond characteristics, typical uses, and materials that can be bonded with each formulation. **149**

METHODS & EQUIPMENT
and Testing

Processing X-Ray Films. Eastman Kodak Co., X-Ray Sales Div., 6 pp, illus. Describes an entirely new system of faster, better processing for industrial x-ray film. **150**

Induction Heating. Lepel High Frequency Laboratories Inc., 12 pp, illus., Vol. 1, No. 6. Information on the use of induction heating equipment in zone refining, zone leveling and crystal growing. **151**

Vacuum Furnaces. New York Air Brake Co., Kinney Vacuum Div., 28 pp, illus. Describes high vacuum furnaces for heat treating, annealing, brazing, melting, alloying and steam degassing of metals. **152**

High Temperature Furnace. Pereny Equipment Co., Inc., 2 pp. Specifications, advantages, and other information on high temperature furnace for applications calling for long periods of sustained high temperature. **153**

Turn to page 53 for current books and reports⟶

Reinserting a 14-foot HK nickel-chromium alloy furnace tube at Security Engineering, Inc., Division of Dresser Industries, Dallas, Texas, after its regular six-month inspection. Upon refiring, these heavy-walled tubes bend back into their normal shape and function perfectly.

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How to select the proper heat-treating alloy. "Heat Resistant Castings, Corrosion Resistant Castings...Their Engineering Properties and Applications" discusses the entire range of heat-resistant casting alloys, and advises what to consider in choosing the right alloy for your needs. A post card will put this 72-page booklet on your desk.

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TECHNICAL LITERATURE

(cont'd from p 51)

Books

Handbook of Thermophysical Properties of Solid Materials. *Edited by Alexander Goldsmith, Thomas E. Waterman and Harry J. Hirschhorn. The Macmillan Co., New York. 1961. Cloth, 8⅜ by 11 in., 5 vols., 4300 pp. Price $90*

This monumental work, almost a reference library in itself, brings together in convenient form all published data on 12 important thermophysical properties of virtually all solid materials.

The 12 properties covered are: density, melting point, latent heat of fusion, latent heat of vaporization, latent heat of sublimation, specific heat, thermal conductivity, thermal diffusivity, emissivity-reflectivity, linear thermal expansion, vapor pressure, and electrical resistivity. All information is presented in data sheet form.

Materials covered include: Vol I—*elements* (with melting points above 1000 F); Vol II—*alloys* (iron, copper, cobalt, refractory metals, light metals, etc.); Vol III—*ceramics* (oxides, mineral, vitreous, covalent, vitreous bonded crystalline, and inorganic cements and adhesives); Vol IV—*cermets* (carbides, oxides, suboxides, borides, silicides, nitrides, hydrides, antimonides, arsenides, phosphides, tellurides, light metals, rare earths, and refractory metals); *polymeric materials* (plastics); and *composite materials* (organic, metallic, ceramic, sandwich structures, etc.). Volume V consists of references and indexes.

Each of the four volumes is arranged in four sections: 1) introductory remarks and explanatory text (including such information as testing method, the experimentor's own estimate of the accuracy of a test, prior treatment of the material or special environment of the test, and sources of each plotted point or numerical value); 2) a materials index; 3) tables of conversion factors; and 4) the body of data.

The handbook should prove valuable for design engineers, metallurgists, ceramic engineers, polymer chemists, and all other scientists and engineers working with materials at high temperatures.

The Rare Earths. *Edited by F. H. Spedding and A. H. Daane. John Wiley & Sons, Inc., New York. 1961. Cloth, 6 by 9¼ in., 641 pp. Price $14.75*

Containing the proceedings of a symposium sponsored by the American Society for Metals and the U.S. Atomic Energy Commission, this book gives authoritative coverage to the separation, preparation, and properties of rare-earth metals and alloys. Specific subjects include: chemistry, separation, preparation, fabrication, physical and mechanical properties, crystallography and metalography, phase diagrams, alloying behavior, and applications.

High Strength Steels for the Missile Industry. *Edited by H. T. Sumsion. American Society for Metals, Novelty, Ohio. 1961. Cloth, 8½ by 11 in., 276 pp. Price $12*

This book, designed for the materials and process engineer, discusses problems in development and application of ultra high strength metals. Consisting of papers presented at a recent symposium, the book considers such things as materials and fabrication problems in pressure vessels, stress corrosion of aircraft and missile steels, fracture theory in pressure vessels, high strength sheet alloys, new ultra high strength steels, spinning and deep drawing, and future applications of high strength steels.

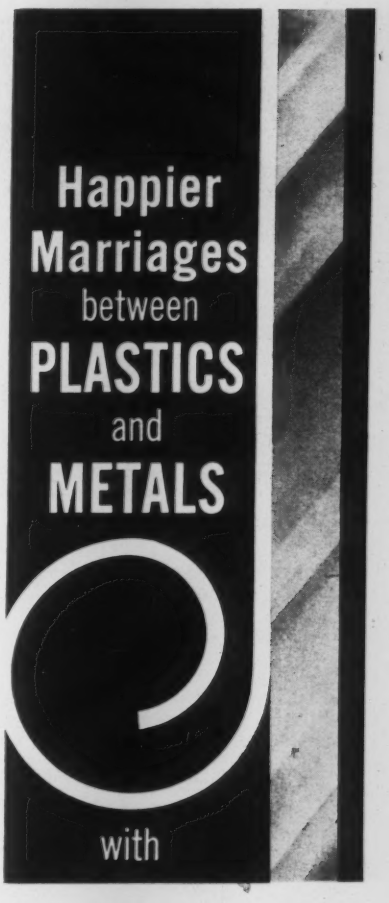
Reports

Tungsten-base alloys PHYSICAL AND MECHANICAL PROPERTIES OF TUNGSTEN AND TUNGSTEN-BASE ALLOYS. *V. D. Barth, Defense Metals Information Center, Battelle Memorial Institute. Mar '60. 67 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.75 (PB 151 084)*

Molybdenum-base alloys PHYSICAL AND MECHANICAL PROPERTIES OF COMMERCIAL MOLYBDENUM-BASE ALLOYS. *J. A. Houck, Defense Metals Information Center, Battelle Memorial Institute. Nov '60. 182 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $3 (PB 151 099)*

Chemical milling CHEMICAL MILLING. *C. H. Rose, Watervliet Arsenal. Dec '60. 21 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 75¢ (PB 171 112)*

Although "removal of metal through chemical erosion is nothing new, only now have techniques been perfected to apply chemical milling accurately and precisely enough to produce highly complex shapes, nonsymmetrical patterns, intricately stiffened structures, and tapered skin." Breakthrough in this field is attributed by the report to 1) new organic coatings and tapes resistant to different types of solutions; 2) compounds or modified etching solu-



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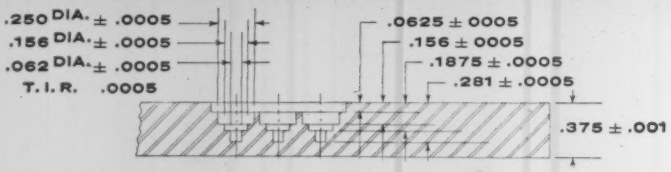

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TECHNICAL LITERATURE

tions that give uniform etching rates without destroying the physical or chemical properties of a metal; and 3) electronic measuring and control equipment.

Stainless steels SOME PHYSICAL PROPERTIES OF MARTENSITIC STAINLESS STEELS. *Defense Metals Information Center, Battelle Memorial Institute. Sept '60. 32 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 161 218)*

Chemical compositions and physical and mechanical properties of 11 commonly used martensitic stainless steels.

Cryogenics REVIEW OF CURRENT DATA ON THE TENSILE PROPERTIES OF METALS AT VERY LOW TEMPERATURES. *J. E. Campbell, Defense Metals Information Center, Battelle Memorial Institute. Feb '61, 79 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2 (PB 151 107)*

Current information on the tensile properties of eight metals and alloys at cryogenic temperatures. Covers aluminum, copper, magnesium, nickel, cobalt and titanium alloys; low alloy and stainless steels; and tantalum and columbium.

Organic semiconductors Two reports provide information on the effects of temperature on the resistivity of organic semiconductors. Both are available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C.

ORGANIC SEMICONDUCTOR STUDY. *J. B. Rust and others. Wright Air Development Div., U. S. Air Force. June '60. 58 pp. Price $1.75 (PB 171 177)*

INVESTIGATION OF ORGANIC SEMICONDUCTORS. *G. P. Brown and S. Afterbut, Wright Air Development Div., U. S. Air Force. Sept '60. 76 pp. Price $2.25 (PB 171 340)*

Nonmetallic wear MECHANISM OF WEAR OF NONMETALLIC MATERIALS. *E. J. Latos, Wright Air Development Center. Oct '59. 14 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 171 474)*

Describes a device designed to measure the friction properties of sapphire and quartz crystals under temperatures ranging from room to 1600 F. Discusses load, speed, temperature, surface hardness, and bulk mechanics.

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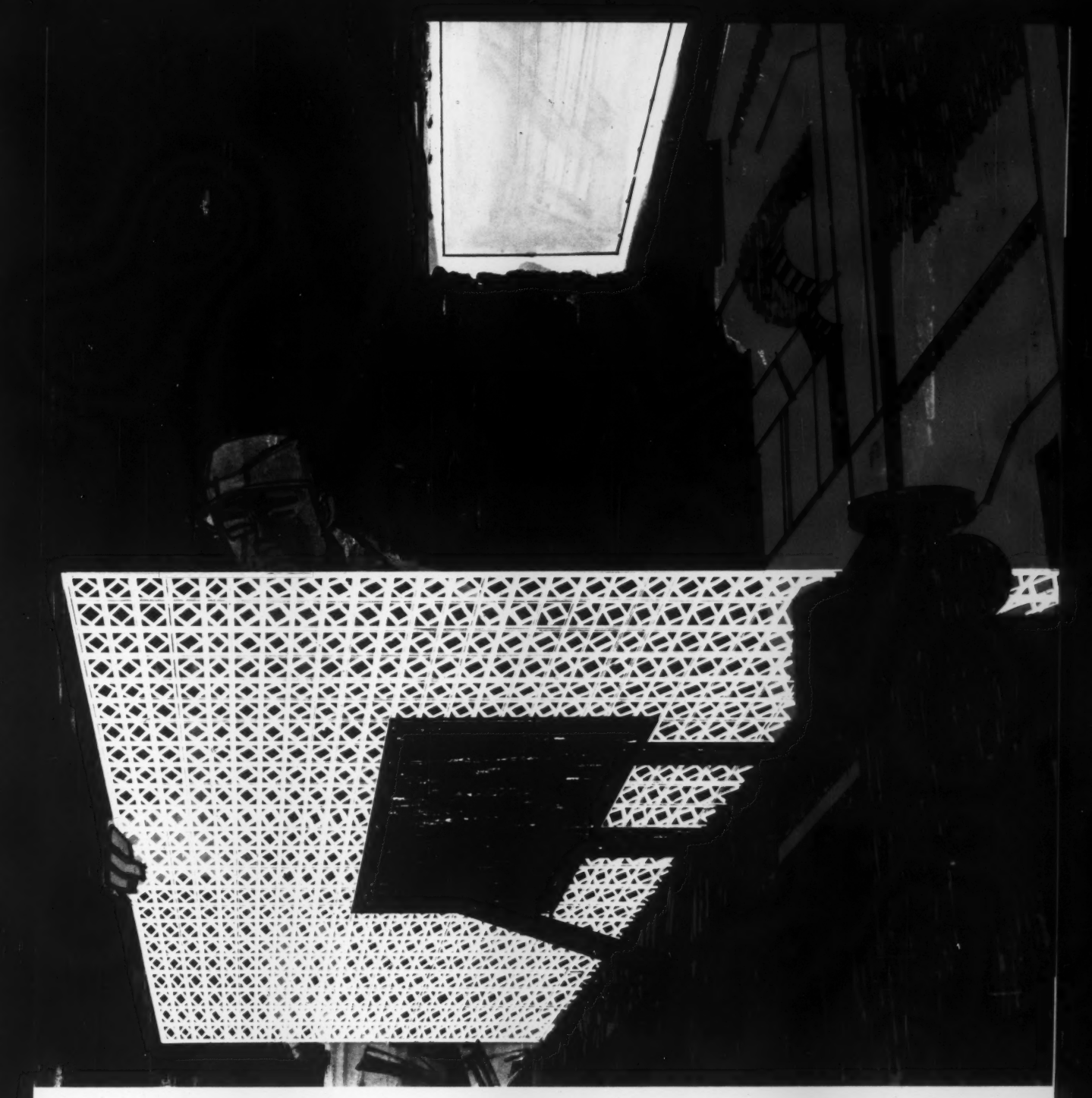

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STRENGTH			
TENSILE			
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212°F	28	4.5 - 5.5	(@ 160°F) 2.9 - 4.6
IMPACT			
ft.-lbs./in. @ −40°F	2	1.2 - 1.8	1 - 2.5
@ 73°F	43	1.4 - 2.3	3 - 9
	Un-notched Charpy	Notched Izod	
COMPRESSION			
1000 psi	60	12 - 18	2.5 - 11
STABILITY			
COEF. OF LINEAR EXPANSION PER °F	.0000152	.000045	.000078 - .00010
WATER ABSORPTION 24 hr. Immersion in %	0	0.12	.2 - .3
MOLD SHRINKAGE in./in.	.004	.020	.005

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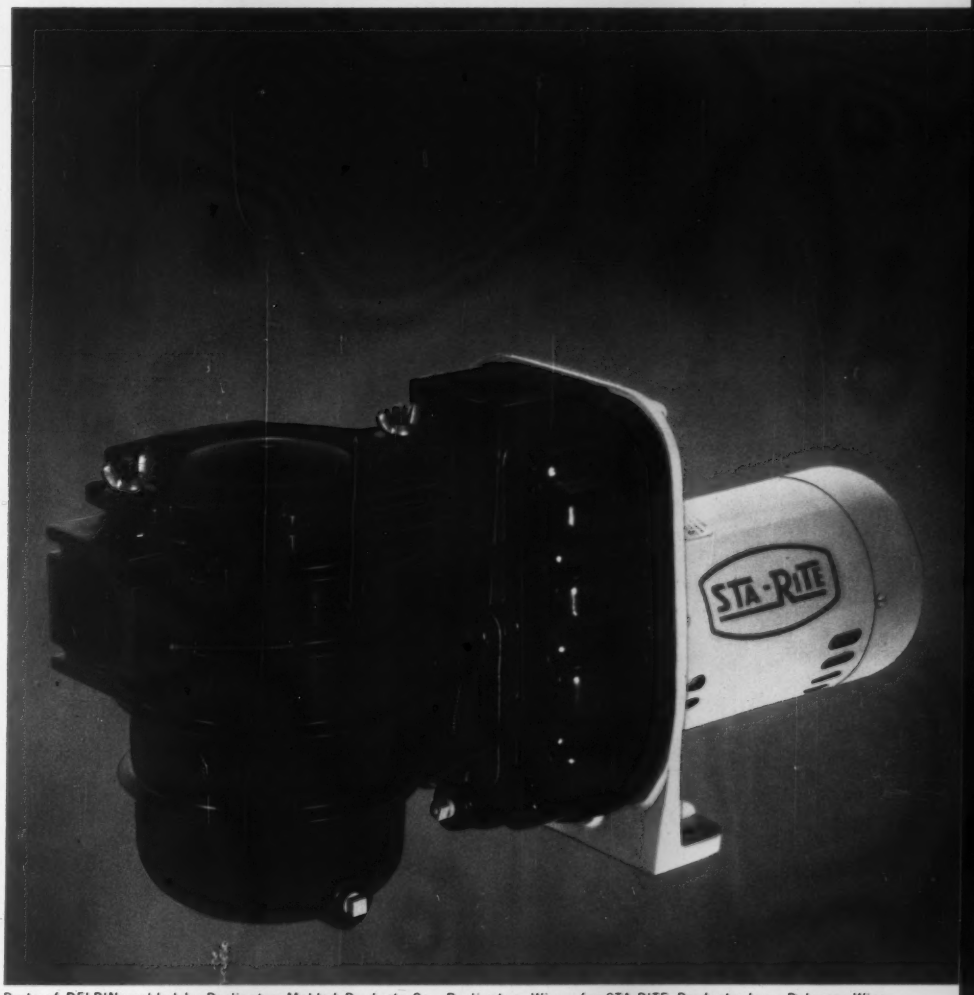

Parts of DELRIN molded by Burlington Molded Products Co., Burlington, Wisc., for STA-RITE Products, Inc., Delavan, Wisc.

Corrosion-proof parts of DELRIN® meet rugged requirements of new swimming-pool pump

Swimming-pool pump must resist corrosion, abrasion and galvanic action. Parts of DELRIN acetal resin in new self-priming pump do just that. Field testing of pumps shows excellent results: burst tests included pressures up to 190 psi.

The pump has a body, suction trap and trap cover of DELRIN. These parts, among the largest ever molded of DELRIN, weigh a total of seven pounds. The pump (1/3-2 h.p.) is designed for use with swimming-pool filters and has a maximum capacity of 120 GPM and a shutoff head of 100 feet.

In addition to being corrosion-proof, DELRIN provides the pump parts with (1) high hoop strength and creep resistance to withstand the large stresses resulting from internal water pressure, (2) outstanding fatigue endurance under cyclic pressures, (3) good shear and thread strength to permit direct installation of piping to pump, (4) retention of metal inserts in pump body without cracking or crazing around inserts.

Turn page for other examples of how the properties of DELRIN acetal resin improve performance and reduce costs of products in other industries.

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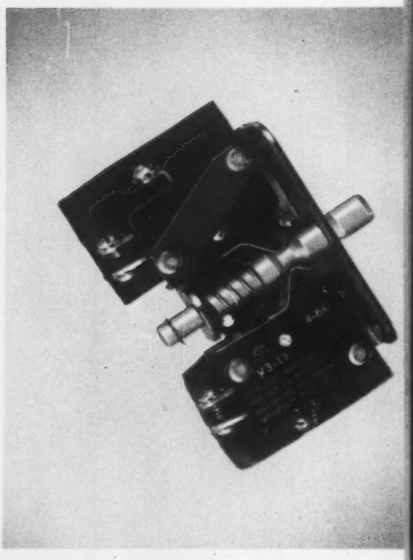
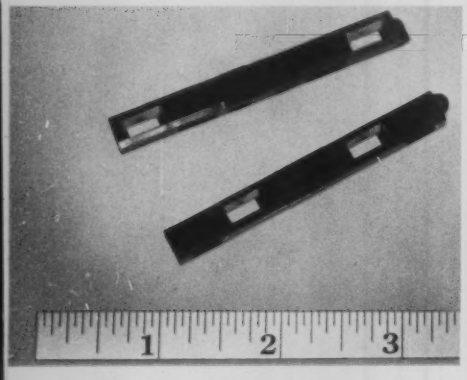
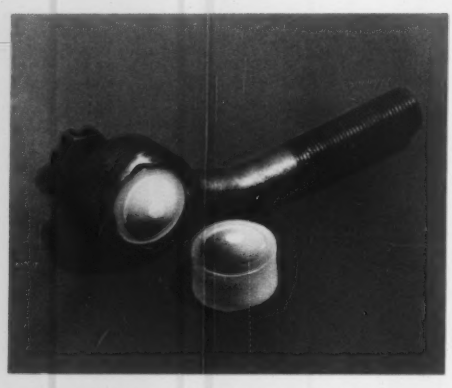


Door interlock switch plungers molded of DELRIN assure switches an extra-long life. Although the average life expectancy of these switches is normally 100,000 operations, they have survived even 1,000,000 operations in satisfactory condition, outwearing previously used steel 5 to 1. Plungers of DELRIN operate smoothly without lubrication and have high strength and exceptional wear resistance. The switches are commonly used in panels for electronic equipment. (MICRO SWITCH, a division of Honeywell, Freeport, Illinois.)



Electric typewriter carriage roller trucks molded of DELRIN are stiff and strong, yet are resilient enough to flex and accept steel rollers which snap-fit into holes. This design is not economically feasible in metals. Use of corrosion-proof DELRIN has practically eliminated assembly problems such as flash or breakage. (Molded by Hydro Plastics, Inc., Georgetown, Kentucky, for IBM Corp., Electric Typewriter Division, Lexington, Kentucky.)



Steering linkage ball seats molded of DELRIN give "greased for life joints" on many 1962 automobiles. Replacing older steel-to-steel joints, new joints with the low coefficient of friction of DELRIN give a smooth, even feel to steering. DELRIN is tough over a wide range of temperatures (–40°F. to 250°F.). Severe tests proved that DELRIN has the dimensional stability and resistance to creep needed for a permanent tight fit, sealing in the lubricant.

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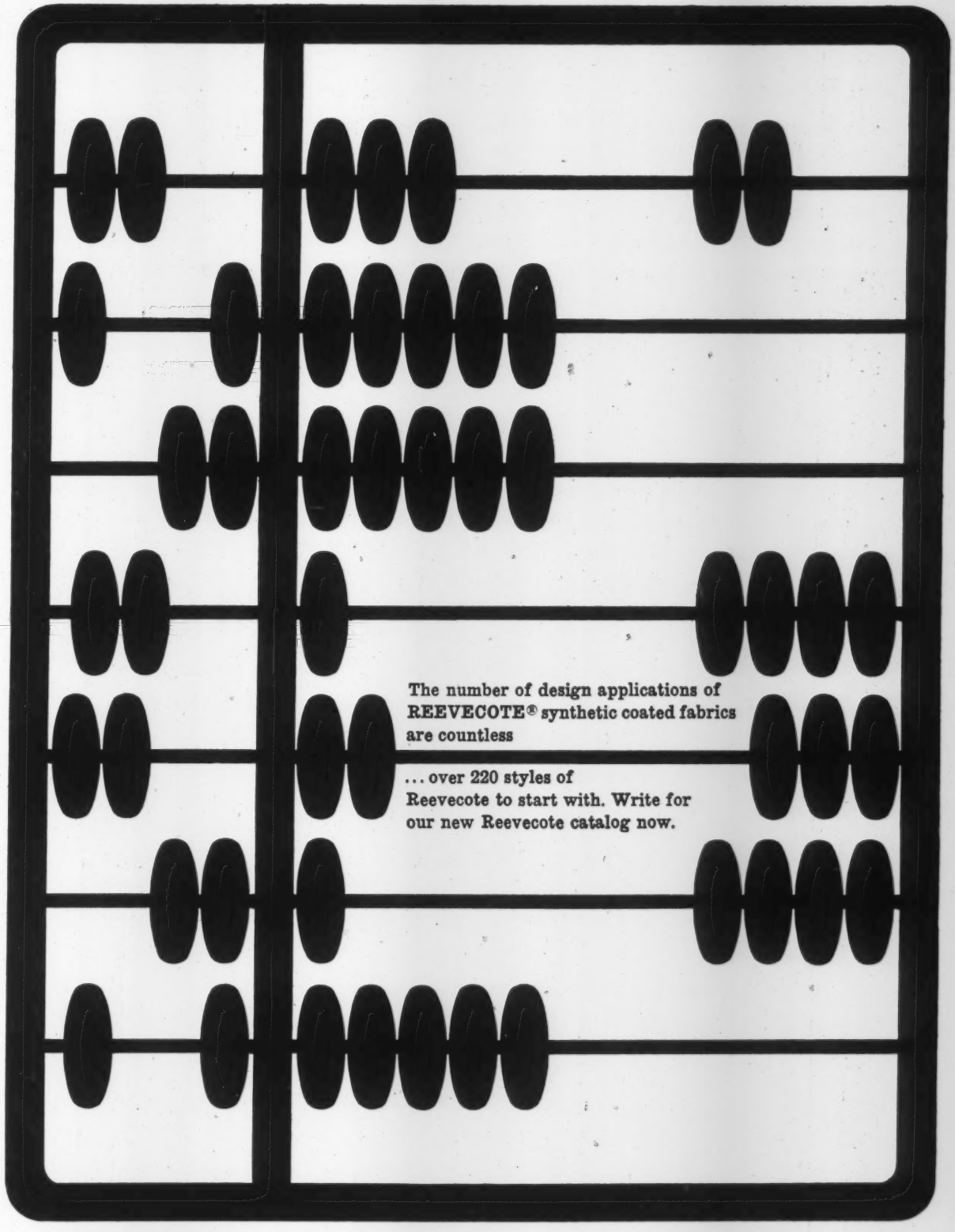
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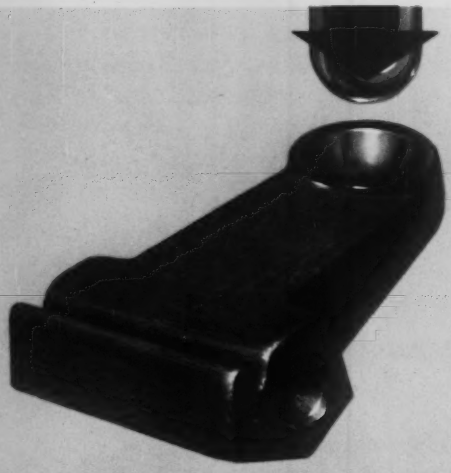
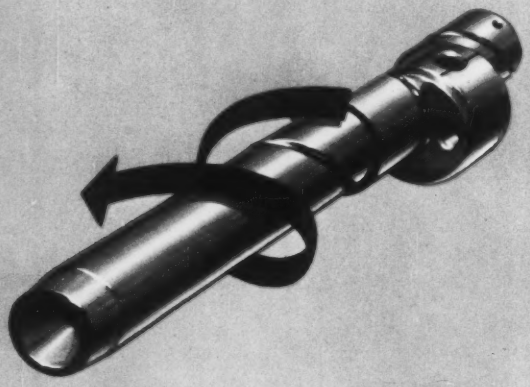
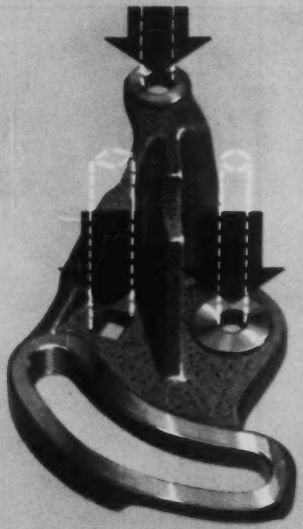
MALLEABLE
CASTINGS COUNCIL



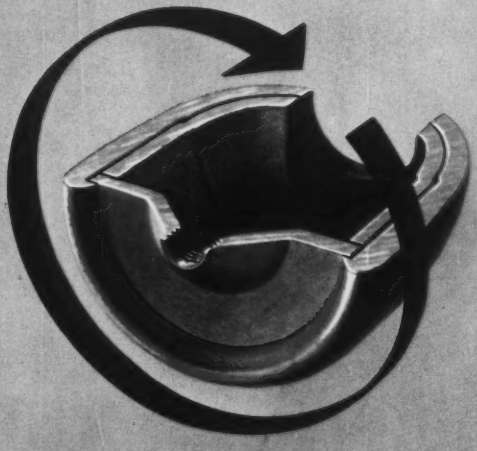
Hot Form It — Hot coining this Malleable transmission part reduces finished cost . . . eliminates three cutting operations required by the previously used steel part.



Roll It — Oil grooves in lawnmower crankshafts and splines in compressor crankshafts are just two of many places where rolling proves more economical than machining.



Punch It — Holes with diameters greater than the thickness of the metal can be punched in Malleable. Two round holes and a square hole are punched simultaneously in this idler arm.



Spin It — Malleable's ductility permits the sleeve and end disc in this ball joint to be held in place by spinning the Malleable housing into a strong, permanent flange.

Get the most for your metals dollar... get MALLEABLE

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Alloy Foundries Division,
The Eastern Co., Naugatuck

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company,
Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division
Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div.,
Columbus 16
National Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

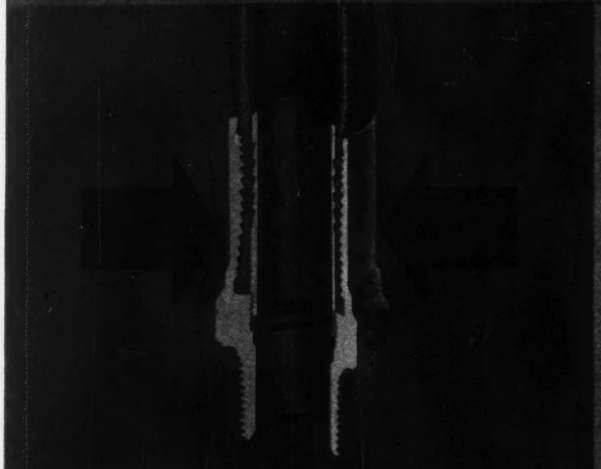
TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc.,
West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works,
Milwaukee 46

Bend It — A 20% cost reduction was achieved by casting this Malleable iron twine finger flat . . . then bending the arm about 45 degrees and coining the center hub in one fast, post-forming operation.

Coin It — Very close tolerances are often met economically by either cold or hot coining. The head of this T-bolt is coined to meet tolerances of ± .005" on its .475" width without any machining.

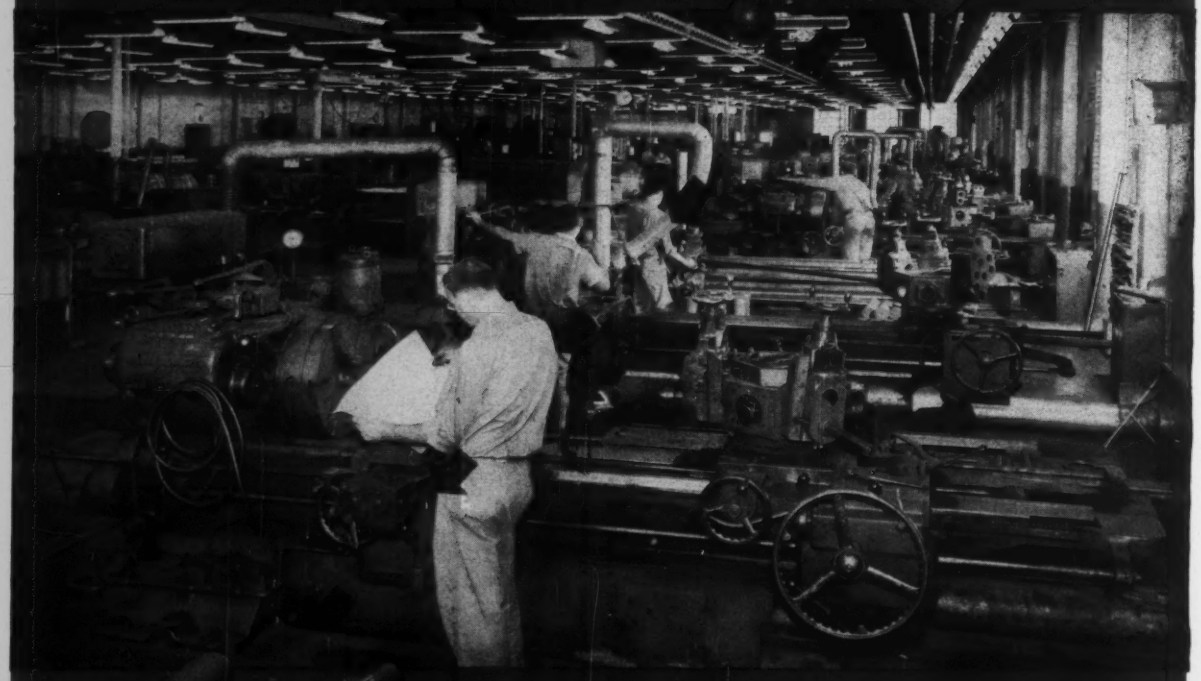


Harden It — Surface hardness values in excess of 55 Rockwell C can be achieved with pearlitic Malleable by either flame or induction hardening. Response is excellent, and results are uniform.

For more information, turn to Reader Service card, circle No. 342

NATIONAL GRAPHITE is available in any size, shape and quantity!

Unmachined...GraphAite is available from minute particles to five ton blocks...in all sizes of square, round, rectangular and cylindrical shapes. Whatever your needs—whether quantity, purity or size—made from standard or special grades—let National Carbon Company quote on your requirements.



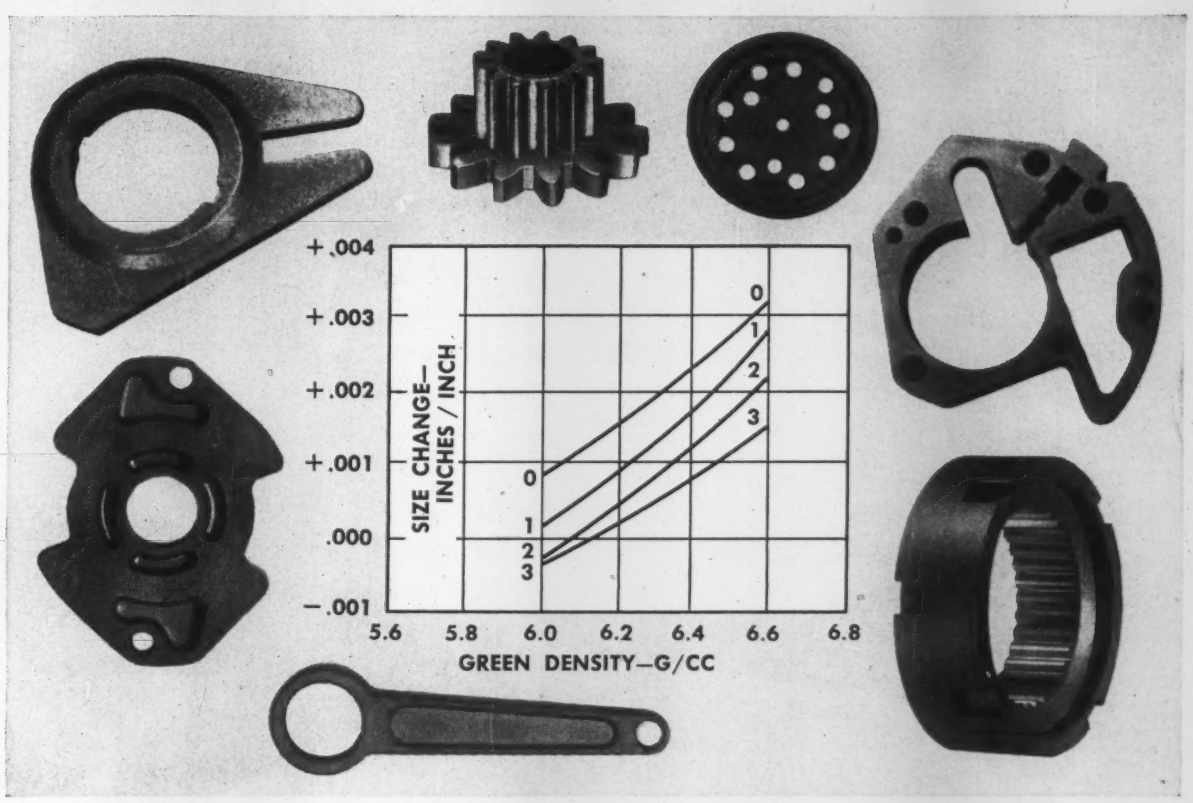
Machined...GraphAite is machined economically at National Carbon Company because we have years of experience handling this unique material, plus several strategically located, modern machine shops. For simple or complex shapes . . . large or small pieces . . . intricate details with close tolerances . . . let National Carbon Company quote the job. For data, contact our representative or the nearest sales office.

"National" and "Union Carbide" are registered trade-marks for products of

NATIONAL CARBON COMPANY
Division of Union Carbide Corporation • 270 Park Avenue, New York 17, New York
IN CANADA: Union Carbide Canada Limited, Toronto

UNION CARBIDE

For more information, turn to Reader Service card, circle No. 398



Better dimensional control, with economy ...when you use A.W. Iron Powder

Little differences in the carbon additive to A.W. Iron Powder can make big savings in your plant.

By use of different types of carbon additives, in iron-copper-carbon mixes, a broad range of dimensional control can be achieved. This provides not only greater latitude in design specifications, but prolongs the service life of your dies. Together, these advantages result in closer tolerances for your molded parts at reduced production costs.

The curves shown above indicate the range of dimensional change obtainable with various types of carbon. *The cost of all these grades is almost identical.*

The Alan Wood 50-ton-a-day direct reduction plant, backed by years of metallurgical research, offers you the most advanced technology in Iron Powder. Make Alan Wood your Iron Powder headquarters for dependable uniformity and delivery, as well as technical advisory service.

ALAN WOOD STEEL COMPANY

CONSHOHOCKEN, PA.

FOR MORE INFORMATION

IRON POWDER DIVISION
ALAN WOOD STEEL COMPANY
Conshohocken, Pa.

Please send me A.W. Technical Data Bulletin #3, which gives additional details on copper-carbon additives.

NAME AND TITLE_____

COMPANY_____

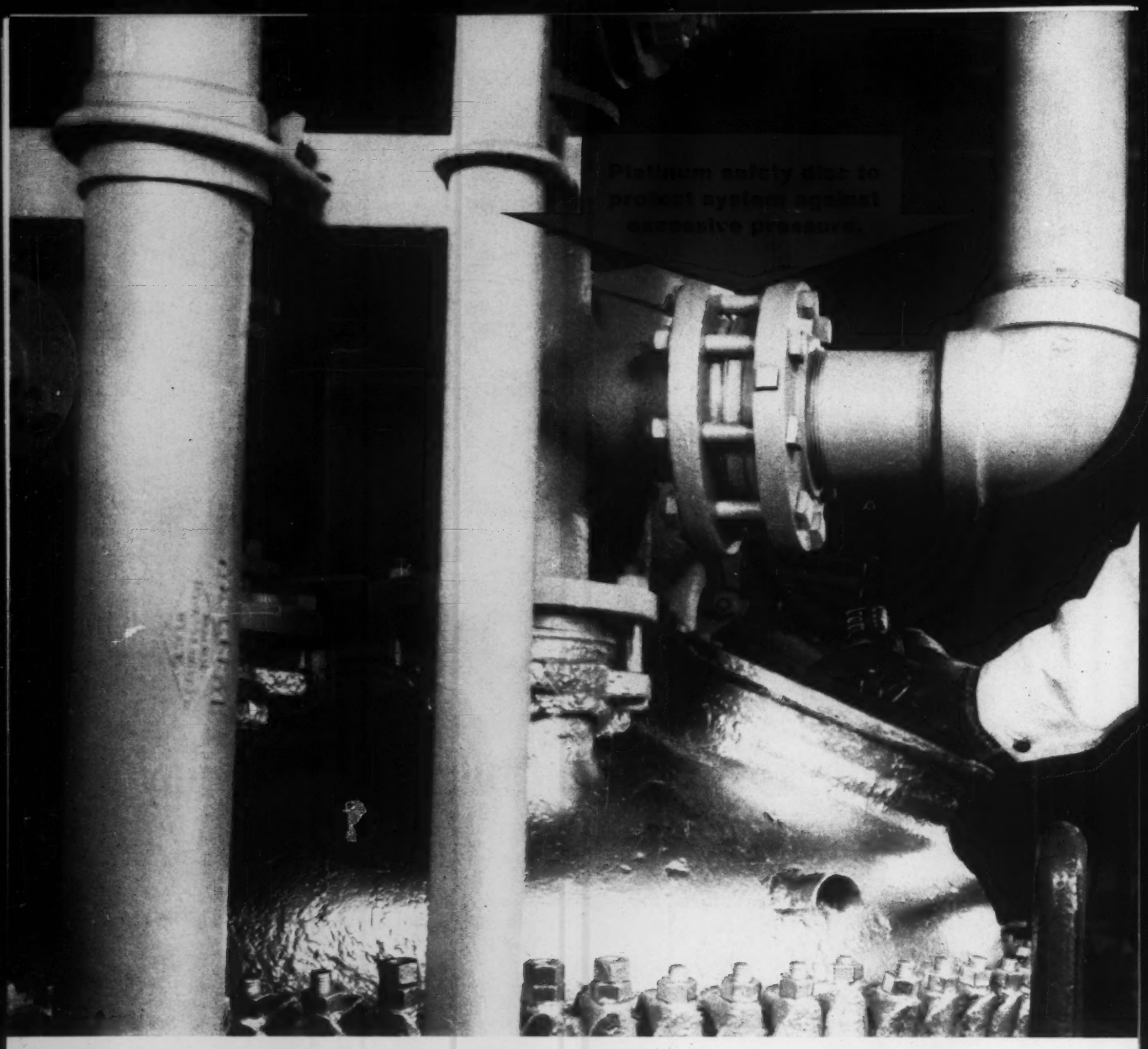
ADDRESS_____

CITY_____ ZONE_____ STATE_____

AMERICAN STEELMASTERS FOR 135 YEARS

For more information, turn to Reader Service card, circle No. 324

For more information, circle No. 337



Where any metal but Platinum

How American Cyanamid uses Platinum to provide sure protection in the production of sulfa drugs

Sulfamethazine, a broad spectrum sulfa used primarily in the veterinary field, is manufactured at American Cyanamid Company's Bound Brook plant. Highly corrosive materials handled in the reactor used in production runs of an intermediate, put the entire processing system under constant corrosion attack.

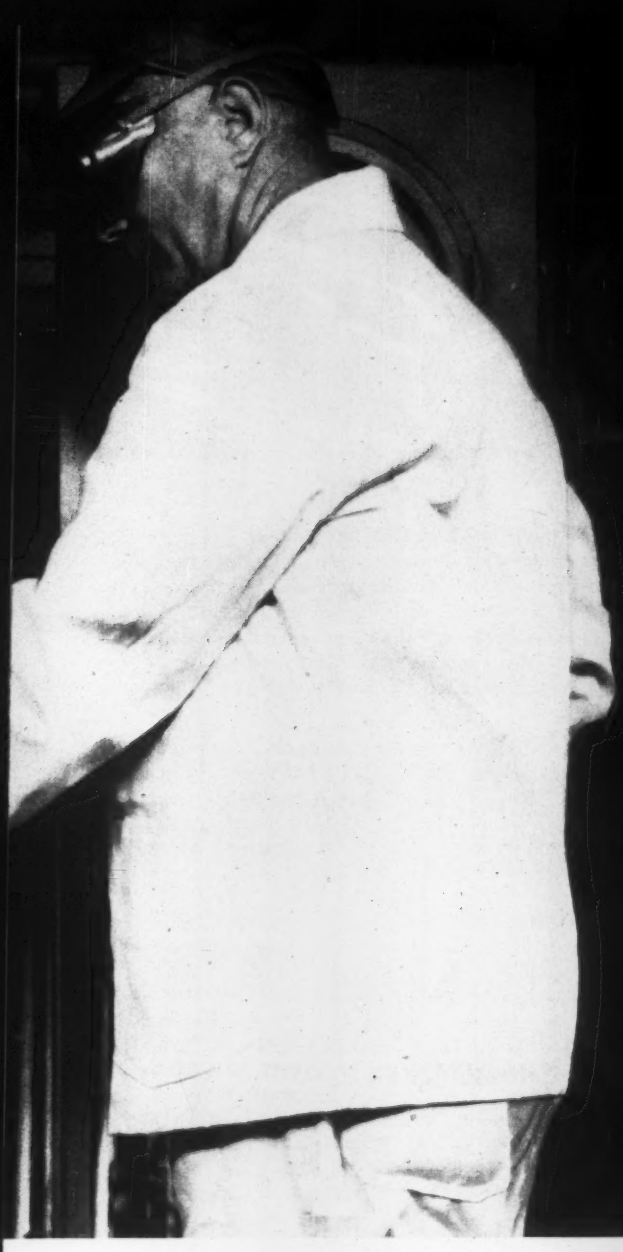
One of the vital components of the system is the safety disc assembly, made to let go at a predetermined pressure should something go wrong. The safety disc is there *in case of emergency*. Yet corrosives are constantly passing this vital checkpoint. Should the disc become corroded by hot chemicals it could malfunction, endangering the entire system.

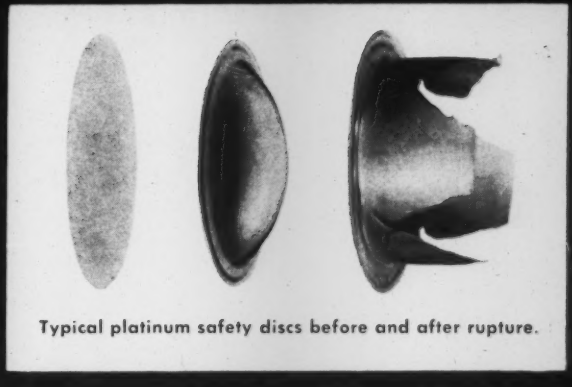
Here is where Platinum's superior corrosion resistance provides sure protection. And with Platinum safety discs, American Cyanamid not only eliminates costly maintenance—but—virtually all of the metal is recoverable after the disc has been ruptured.

On both counts . . . doing the job well and doing it more economically . . . American Cyanamid and others have found Platinum the most suitable material for safety disc assemblies on vessels handling a wide variety of corrosives.

It could pay you to use a Platinum Metal

Your problem might be readily and economically solved with Platinum Metals—where exceptional corrosion resistance is needed to protect the purity of pharmaceutical products and chemicals . . . where high temperature corrosion and spark erosion are involved, such as in aircraft spark plugs . . . where reliable make-and-break electrical contact is indicated, such as in low noise high fidelity transmission . . . where wear-resisting, non-tarnishing surfaces are required, such as for printed electrical circuits . . . where peak catalytic efficiency is required, as in





Typical platinum safety discs before and after rupture.

would cost too much...

the refining of high octane gasoline... the Platinum Metals have proved to be the most economical for certain critical equipment.

Industry is going to higher temperatures and higher pressures. Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. The Platinum Metals have removed many barriers. Have you considered them for your problems?

Platinum, palladium, rhodium, ruthenium and iridium have unique potentials, well worth your attention. Specialists are prepared to work closely with you in evaluating these metals for new commercial and scientific uses.

As a first step, write us for additional data on the outstanding characteristics and successful applications of the six Platinum Metals and their alloys—indicating your field of interest or how we might be of assistance.

CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?

Exceptional Chemical Inertness
High Temperature Stability
Superior Wear Resistance
Peak Catalytic Activity
Low Vapor Pressure

The six Platinum Metals are:

PLATINUM · PALLADIUM · RHODIUM
RUTHENIUM · IRIDIUM · OSMIUM

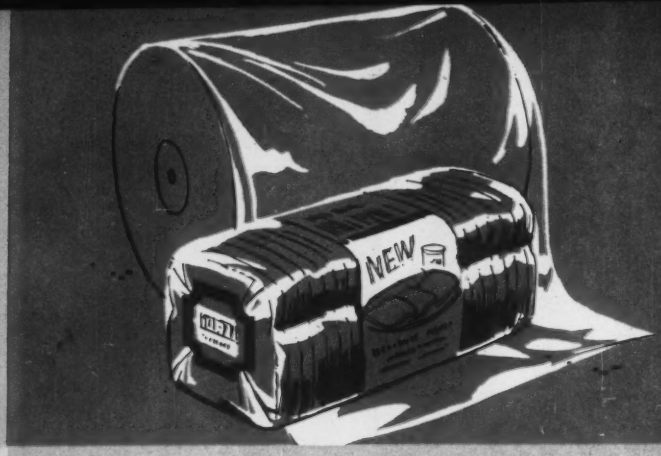
INCO PLATINUM METALS DIVISION, The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.

PROPERTIES: Extremely tough, excellent impact strength, resilient, lightweight, lustrous, weather resistant, dimensionally stable. Available in a wide variety of formulations, including weather-resistant, and an almost unlimited range of transparent, translucent, opaque, metallic and variegated colors plus a crystal-like clear transparent.

Adapted to fast injection molding or extrusion.

TYPICAL USES: Steering wheels, telephone housings, business machine keys, tool handles, football helmets, industrial pipe, skin and blister packaging, outdoor signs, architectural panels, warning light flasher lenses.

TENITE® BUTYRATE



PROPERTIES: Flexible or semi-rigid, virtually unbreakable, chemically inert, resistant to water and moisture transmission and to most strong acids. Excellent electric insulator. Available in natural or wide range of colors and color concentrates, with or without an antioxidant.

Formulations are available—in low, medium, or high density—for injection or blow molding, or continuous extrusion.

TYPICAL USES: Housewares, toys, bottles, packaging film, pipe and tubing, electric cable wrap and wire coating, and coatings for paper, film, and foil.

TENITE® POLYETHYLENE

PROPERTIES: The original Tenite plastic, offering a wide range of desirable properties including toughness, light weight, impact strength, enduring luster and low heat conductivity. Available in a variety of formulations and almost unlimited colors.

Adapted to fast injection molding or extrusion.

TYPICAL USES: Small appliance housings and parts, figurines, containers, toys, novelties, lamp shades, handles, vacuum cleaner parts.

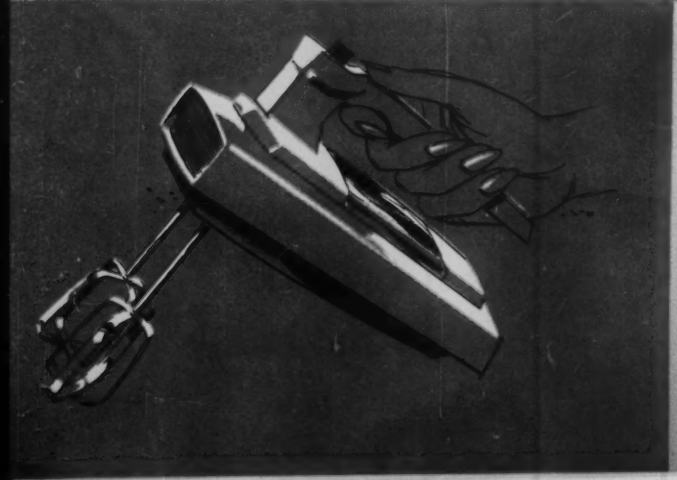
TENITE® ACETATE

TENITE® PROPIONATE

PROPERTIES: A cellulosic with physical properties that, in general, range between those of Acetate and Butyrate. Available in a variety of formulations and a wide range of clear and opaque colors.

Adapted to fast injection molding or extrusion.

TYPICAL USES: Safety goggles, telephone housings, handles, packaging sleeves, cosmetic cases, pen and pencil barrels, jewelry cases, eyeglass frames.



TENITE®

plastics facts for starting ideas...

Six versatile TENITE Plastics give you a wide selection of properties for tough, durable products sparkling with a lustrous finish and virtually unlimited in color. More than 42,000 hues and color effects are already on file in the Tenite Color Laboratory. Whether your plastic application is for indoor or outdoor use, you can find exciting possibilities in TENITE Butyrate, Propionate, Acetate, Polyethylene, Polypropylene, and Polyester. There is a formulation to meet your design needs...to satisfy your performance requirements...to suit your manufacturing facilities.

Tenite representatives are technically trained and ready to help in the design or production of plastic products. You'll find their addresses listed under "Plastics —Tenite" in the classified telephone directories of these cities: Atlanta, Chicago, Cleveland, Dallas, Dayton, Detroit, Greensboro (N. C.), Kansas City, Leominster (Mass.), Los Angeles, Minneapolis, New York City, Philadelphia, Rochester (N. Y.), St. Louis, San Francisco, Seattle, Toronto.

EASTMAN CHEMICAL PRODUCTS, INC.
subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE

PROPERTIES: Surface hardness and gloss, tensile and impact strengths, high melting point, excellent dielectric properties, and resistance to abrasion, chemicals, stress cracking, water and moisture vapor transmission. Superior flexural strength and extremely high resistance to flexing fatigue. Polypropylene is one of the lightest of all solid plastics.

Adapted to injection and blow molding, continuous extrusion.

TYPICAL USES: Luggage, appliance housings, packaging film, rigid sheet, wire and cable covering, industrial pipe, outdoor furniture webbing, containers, toys, housewares, blister packaging, foamed electrical insulation, laboratory ware.

TENITE® POLYPROPYLENE

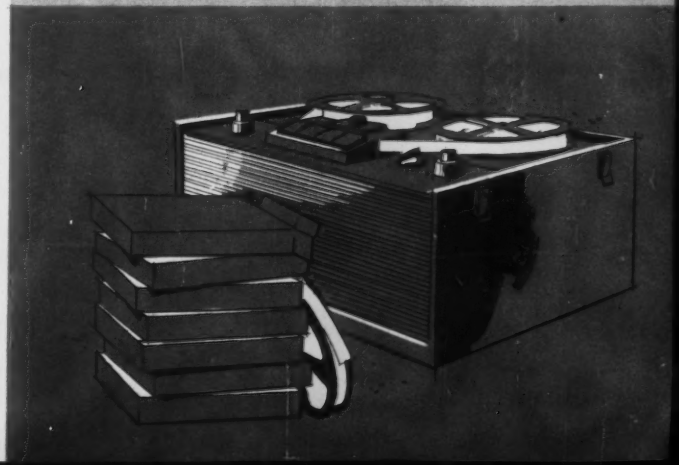
TENITE® POLYESTER

PROPERTIES: Yields sparkling clear film with high strength, resistance to chemicals and most solvents, and dimensional stability resulting from high heat distortion temperature and low moisture absorption. Film properties retained from sub-zero cold to temperatures above boiling water.

Film and sheet available* for metalizing, printing, laminating, stamping, vacuum-forming, and coating with heat-sealable materials.

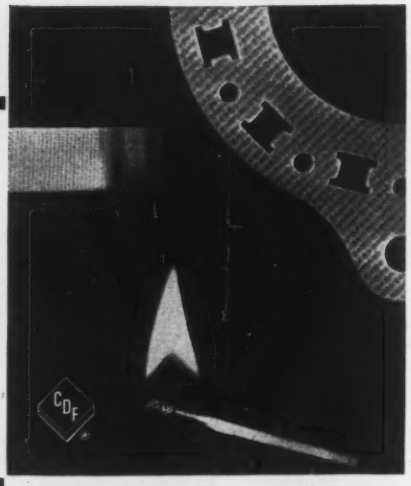
**From Acme Backing Corporation, New York City*

TYPICAL USES: Magnetic tape, metallic yarns, packaging wire and cable tape, boilable pouches.

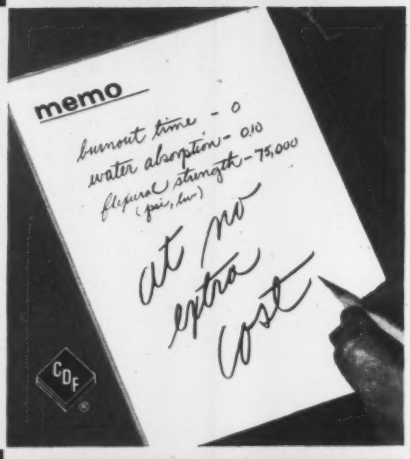


For more information, circle No. 332

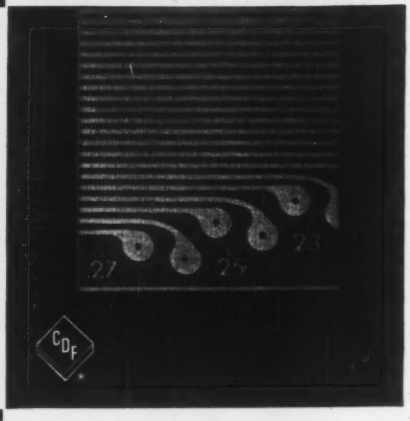
New Copper-Clad *Reliability*



In March, 1961, CDF Grade 614, glass-epoxy laminate, was announced . . . and met with almost overnight acceptance. Particular electronics and electrical manufacturers wasted no time in specifying this premium performance material with zero burnout and minimum "haloing."



By June, 1961, CDF Grade 614 had become the new standard of comparison for applications in critical ground and air-borne circuitry. Designers like its specifications, production men like the way it handles, management likes its reasonable price.

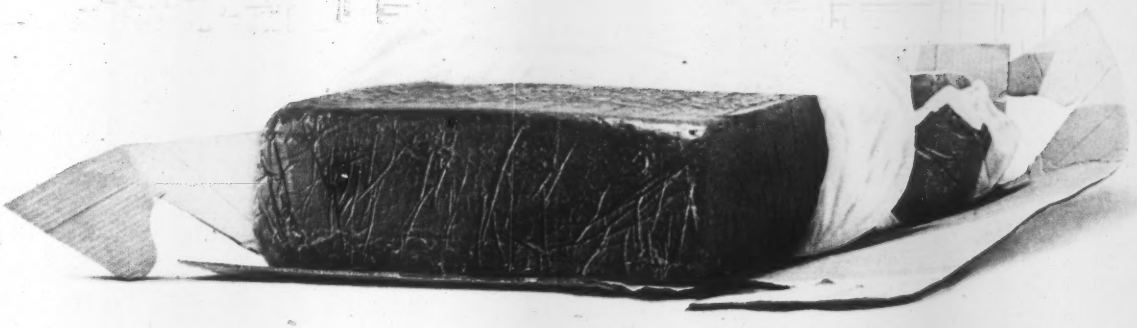


Now, CDF Grade 614 Copper-Clad is setting a new pace among particular producers of printed circuits . . . offering a new high in reliability for high packaging densities . . . and offering researchers a new tool in the investigation of molecular and submicro-circuitry.

You can take advantage of 614 Copper-Clad's unique features right now . . . in research, development or production operations. Continental-Diamond Fibre Corporation, Newark, Delaware. A Subsidiary of the Budd Company.

For more information, circle No. 423 ➤

GOODYEAR



JUST OPENED... a whole new world of improved rubber products made with BUDENE ...new Goodyear polybutadiene rubber!

BUDENE, in combination with natural or with other synthetic rubber, introduces a new dimension to rubber technology—providing consumer products with an exciting new range of end-use properties. BUDENE is the only polybutadiene polymer currently available in both staining and nonstaining types.

Compared to natural rubber, BUDENE gives up to 25% greater abrasion resistance in a 50/50 SBR blend... gives improved aging properties... flexes better... brings you maximum product uniformity and cost stability.

BUDENE is available in commercial quantities from the world's most modern synthetic rubber plant. For samples and outstanding technical help, call your Goodyear Chemical Division representative or write: Goodyear, Chemical Division, Dept. L-9437, Akron 16, Ohio.

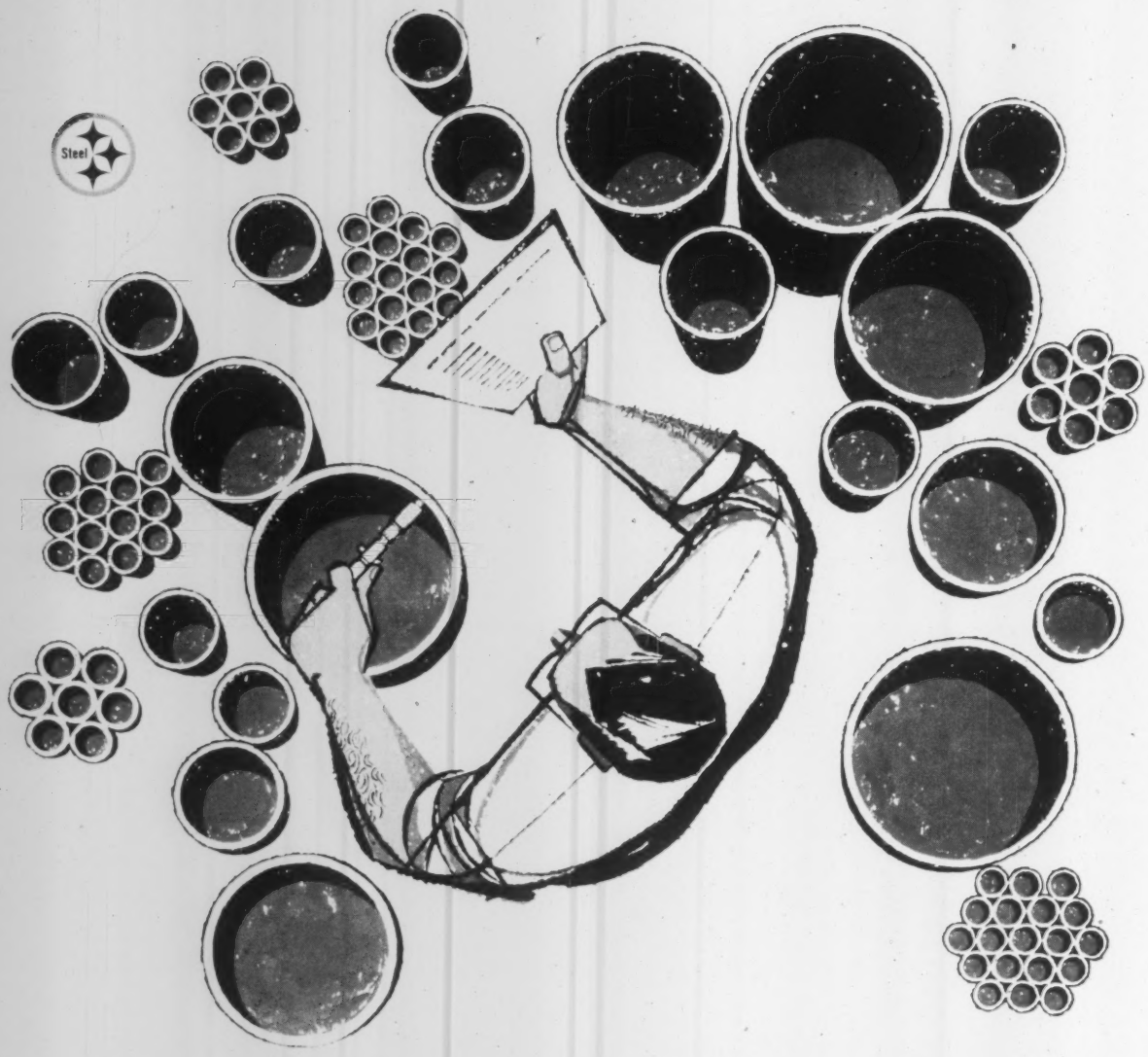
NOTE: Watch for news about NATSYN—Goodyear polyisoprene rubber.

Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Budene, Natsyn—T.M.'s The Goodyear Tire & Rubber Company, Akron, Ohio



"Fitness report" with hundreds of identical copies

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The Babcock & Wilcox Co., Tubular Products Div. *†
The Carpenter Steel Co., Alloy Tube Div. †
Jones & Laughlin Steel Corp., Electricweld Tube Div. *
National Tube Div., United States Steel Corp. *
Ohio Seamless Tube Div., Copperweld Steel Co. *
Republic Steel Corp., Steel and Tubes Div. *†
Sawhill Tubular Products, Inc. *†
Southeastern Metals Co. *
The Standard Tube Co. *†
Superior Tube Co. †
Trent Tube Co., Subs. Crucible Steel Co. of America †
Union Steel Corp. †
Van Huffel Tube Corp. *
Wall Tube & Metal Products Co. †

† PRODUCES WELDED STAINLESS STEEL TUBE
* PRODUCES WELDED CARBON STEEL TUBE

261

Here's the reason why you can count on welded carbon or stainless steel tubing in critical heat transfer applications: its method of manufacture, developed to high domestic standards, results in consistently reliable performance. Starting with clean, scale-free flat rolled steel the resulting tube surfaces are smooth, and free from scratches and pits. You are assured of concentricity, exact O.D. and I.D., precise wall thickness, and uniform ductility for bending or rolling in operations.

Whether you require carbon or stainless steel analyses, listed here are the quality welded tube producers ready to serve you. It will pay you to contact any of them or write for free Booklet 8591, Department MD-6, Welded Steel Tube Institute, Inc., Hanna Building, Cleveland 15, Ohio.

WELDED STEEL TUBE INSTITUTE, INC.

WELDED STEEL TUBE INSTITUTE

For more information, turn to Reader Service card, circle No. 355

These special sections are just a few of the hundreds hot-rolled by Bethlehem.

A. Tractor Track Shoe
B. Lawn Mower Under Knife
C. Concrete Form
D. Curb Facing
E. Coal Mining Bit
F. Automobile Hinge
G. Scraper Blade
H. Railroad Car Brake Beam

Design with Special-Section Steel Bars

FOR: LESS MACHINING . . . LESS SCRAP LOSS
REDUCED STEEL REQUIREMENTS . . . LOWER SHIPPING COSTS
FEWER SHOP OPERATIONS . . . SHORTER PRODUCTION TIME

Steel

. . . for Strength
. . . Economy
. . . Versatility

Bethlehem carbon and alloy steel special sections are hot-rolled to our customer's exact specifications. Thousands of designs are possible—and perhaps one of them can boost the profit in *your* product. Sound interesting? Simply call or write the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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Who else wants to save $100,000 this year?

How the Revere Technical Advisory Service Showed a Metal User the Way to Profit-Protecting Economies — and can do the same for you!

A leading manufacturer—you'd recognize the name immediately—is a heavy user of copper and its alloys. It buys sheet, strip, tube, rod—by the hundreds of tons. Recently, this company invited the Revere Technical Advisory Service to inspect its operations, study its metals needs, analyze its buying practices and look into its specifications. The Revere people were actually treated as members of the crew at the company's plants; nothing pertinent was kept secret, no knowledge hidden.

The result? Recommendations all down the line on every phase of copper and copper alloy procurement and use—and production savings made possible in every area. The Revere Technical Advisor actually showed the way to an astonishing potential saving . . . well over $100,000 yearly!

Naturally, not every company can expect such huge savings. Too many variables enter in. But *if* detailed knowledge of metals, their manufacture and their uses can be applied to *your* product and *your* production, the Revere Technical Advisors are at your service. These are the men who know non-ferrous metals best—and many other metals equally well. They are ready to serve you—*now*.

You can reach the Revere Technical Advisory Service simply by calling or writing the Revere Office nearest you. If you are interested in a cooperative program of this kind and in discussing your metals procedures fully—in confidence—call Revere today. You will find that you have taken the first step toward profit-protecting economies. No obligation, of course.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford and Plymouth, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities.

Distributors Everywhere

For more information, turn to Reader Service card, circle No. 392

Spaulding FIBRE FACTS FOR ENGINEERS NUMBER 5

How to Achieve Permanence at Low Cost

by K. H. Alverson, Product Standards Director

Seldom is a high degree of permanence found associated with the characteristics of dielectric strength, rugged structural strength and arc resistance at such low cost as in Vulcanized Fibre. This permanence and strength allows the engineer to use Vulcanized Fibre to replace more expensive plated or coated parts even where insulating or arc resisting properties are not required.

The reason for Vulcanized Fibre's agelessness lies in the chemical action of its production which arrests the natural tendency of cellulose to deteriorate. This renders Vulcanized Fibre more stable than the hardest wood. (Corrosion, such as attacks metals, is completely precluded since Vulcanized Fibre has a non-mineral base.)

The permanence of Vulcanized Fibre in use is well illustrated by its application as insulation in transformers, switchgear, and circuit breakers. Parts such as corrugated duct spacers, arc chutes and barriers are subjected to terrific arc exposure and must maintain their form, strength and electrical properties for years under continuous operation in hot oil. Lightning arresters and high voltage fuses, made from Fibre tubing for protecting power line transformers, are still in service and operation, in satisfactory condition, after more than twenty years of use.

Industrial fuses with a fibre case and replaceable fuse link are one of the best known uses for Fibre tubing. If the fuse blows, the link is simply replaced and the fuse case used over and over again.

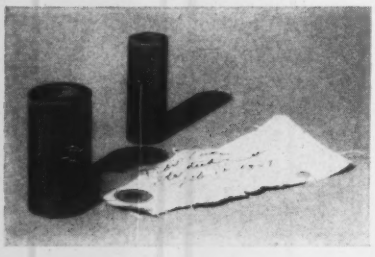
Fibre grommets are used to form a permanent locked-in-place insulator in metal assemblies, such as clocks, motors, etc. They will not deteriorate and fall out as will rubber. Fibre grommets for such applications are approved by the Underwriters' Laboratories.

Fibre is non-corroding, unaffected by oils, greases, solvents, etc. It withstands the pounding of heavy trains when used as track insulation under outdoor exposure. Easily formed into complex shapes for use in athletic equipment, welding helmets, etc., all of which must withstand harsh usage without failure.

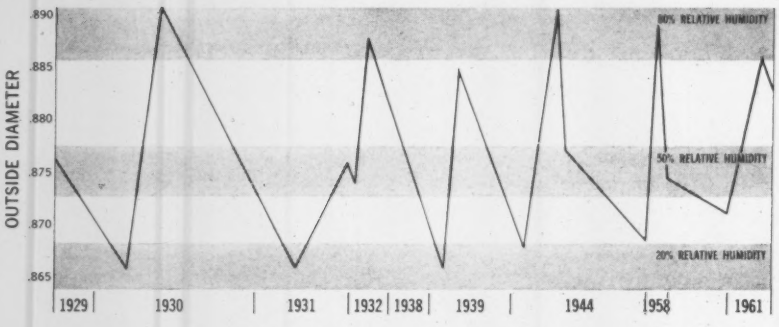
Trunk coverings, sample cases, factory trucks and waste baskets have been made for years of Vulcanized Fibre to take advantage of the light weight, abrasion resistance and permanence of the material.

Because of its many unique characteristics, Vulcanized Fibre offers a virtually endless variety of applications.

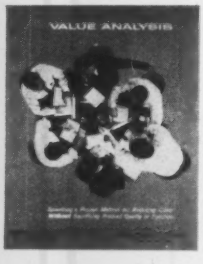
Spaulding Engineers who have been trained in Value Analysis can help you take advantage of the wide range of possibilities in designing to reduce costs through the use of Vulcanized Fibre parts. They also make available to you Spaulding's extensive fabricating facilities and experience in working with this extraordinary material.



While many materials deteriorate over the years, Vulcanized Fibre maintains its essential properties for decades. Note how the linen tag attached to Fibre tube samples in 1929 shows age, but Fibre tubes look and act as they did 32 years ago.



Long term test of fibre, which has been going on since 1929, shows that fibre still responds to wide humidity changes in the same way it did when test began. Predictable changes in dimension occur when fibre tubing is subjected to extremes of humidity. Tests such as these prove that there is no change in Vulcanized Fibre characteristics over long periods of time.



Be sure to add this FREE Literature to your reference files. *WRITE TODAY.*

New Value Analysis Brochure a detailed review of the Spaulding Value Analysis technique together with case histories of design improvement and cost reductions that have been accomplished through Spaulding's Value Analysis of customer products. 12 pages.

Vulcanized Fibre Engineering Data — a design reference book which comprehensively covers all the application specs of Vulcanized Fibre. 10 pages.

SPAULDING FIBRE COMPANY, INC.

358 Wheeler Street • Tonawanda, New York

For more information, turn to Reader Service card, circle No. 403

Linde materials & coatings News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Polish semiconductors scratch-free with 99.98% pure alumina powders

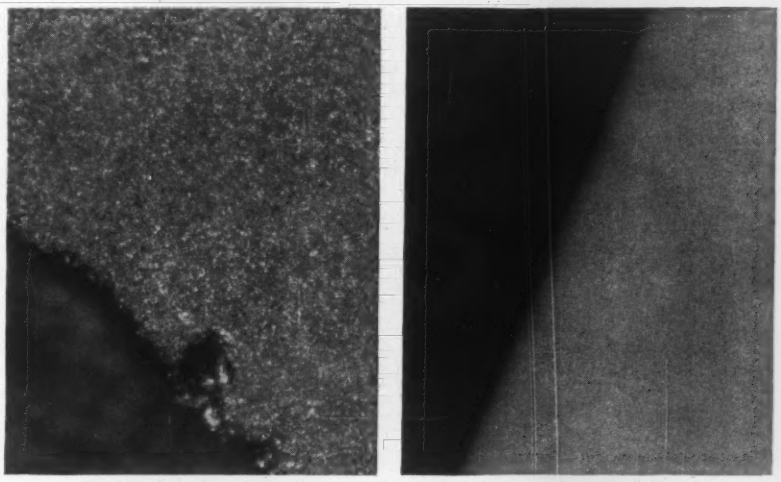


Photo at left: A typical as lapped silicon wafer, showing edge chip, prior to finishing. *(Magnified 42X).* **Right:** Complete polishing with LINDE alumina abrasives leaves edge of silicon and wafer scratch-free. *(Magnified 144X).*

The surfaces of the semiconducting wafers used in the new high-speed mesa switching transistors and planar diodes must have a superior surface finish, flatness, and parallelism—prior to final etching and diffusion. This effect is now being achieved in full production with high-purity alumina abrasives produced by LINDE.

Three particle sizes

Three basic particle size ranges of aluminum oxide powders suitable for polishing silicon and germanium wafers are available for this application, as well as many others. The difference in size and hardness, as listed below, give these 99.98% pure powders their individual properties.

	TYPE 0.3A	TYPE 0.05B	TYPE 1.0C
Formula	Al_2O_3 (Alpha)	Al_2O_3 (Gamma)	Al_2O_3 (Alpha)
Crystal System	Hex.	Cubic	Hex.
Hardness, MOHS'	9	8	9
Size, Microns	0.3	0.05	1.0

Type 1.0C is used to remove stock from surfaces that are rougher than 6 microinches rms; Type 0.3A for preliminary polishing, and Type 0.05B for final polishing of the wafers.

In the initial stages of junction transistor or diode production, the powders can be used for preparing metallographic cross-sections of the assemblies according to standard methods on a horizontal polishing wheel. For semiconductors, LINDE has developed several adaptations of standard techniques.

Extremely uniform

LINDE Types A, B, and C alumina powders are chemically prepared and have an extremely uniform ultimate particle size which obviates any further levigation before use. By simple reference to a specific lot number, succeeding production lots can be ordered with abrasive properties tailored to an individual application.

For data on semiconductor and other critical polishing, check the coupon.

Flame-Plated tungsten carbide coatings precision-finished

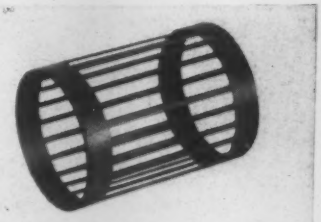
Tungsten carbide coatings, applied with the LINDE Flame-Plating process, are being used successfully on hundreds of precision parts because the coatings are well suited for finishing down to 1 microinch rms.

Most frequently used precision grinding equipment is diamond wheels, resulting in lowest overall cost on ordinary cylindrical and flat work. On many contour grinding jobs, special grades of silicon carbide wheels will do the job, eliminating the high cost and lack of precision associated with shaped diamond wheels. Diamond-abrasive lapping techniques give high finishes.

Get complete data on Flame-Plating precision parts—send the coupon.

Plasma-Plate process applies thin dielectric coatings

Next time you need a low-cost, thin dielectric coating for cathode cups, consult Linde Company. LINDE's Plasma-Plate process has economically put alumina insulation coatings on molybdenum cups, and has even built structures on mandrels—for example, the grid cage shown below. This inert gas process can apply refractory metals melting up to 7100° C., also metal carbides, borides, and oxides, to a variety of base metals. Discuss your requirements with us. For further information, check and send the coupon.



Tungsten grid cage—intricate structure built up on mandrel using the Plasma-Plate process.

CHECK—CLIP COUPON—ATTACH TO BUSINESS LETTERHEAD

Linde Company, Dept. MI-12
270 Park Avenue
New York 17, N.Y.

Please send details on the items checked:

- ☐ LINDE Alumina Abrasive Powders
- ☐ LINDE Finishing of Flame-Plated Parts
- ☐ LINDE Plasma-Plated Dielectric Coatings

UNION CARBIDE

LINDE COMPANY

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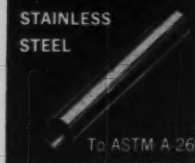
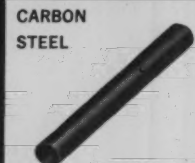
REPUBLIC STEEL..

CARBON STEEL
To ASTM A-178
BOILER TUBES



STAINLESS STEEL
To ASTM A-269
CONDENSER TUBES

STAINLESS STEEL
To ASTM A-270
SANITARY TUBES



CARBON STEEL
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Schedule 40S
PIPE

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For Exhaust Stacks
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EVAPORATOR TUBES

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¾" Thru 6" O.D.
16 Gage and Heavier
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SPECIAL SHAPES

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CARBON STEEL
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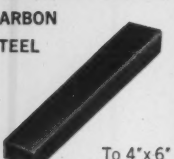
METALLIZED TUBES

STAINLESS STEEL
O.D.—I.D. or Both
POLISHED TUBES



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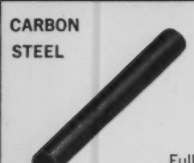

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For Mechanical Use
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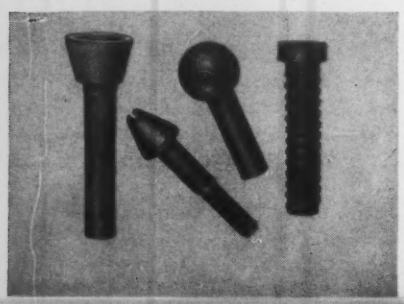
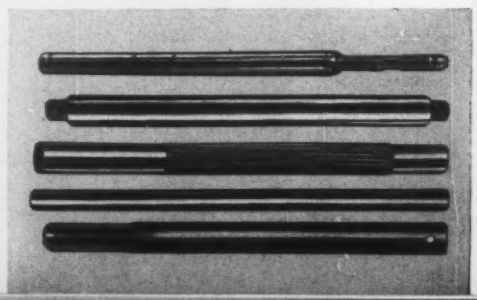
Strong, Modern, Dependable

PROBLEM-SOLVING KNOW-HOW AND EXPERIENCE have made Republic a leader in custom production of Fastener and Formed Parts "Specials." Whenever standard fasteners can't do the job, you'll save time and money by contacting Republic. Write for data on Republic design, engineering, and production services.



TRIM COLD FINISHED BAR COSTS. Republic's CENTURY SERIES offers five grades of high-strength, stress-relieved, cold finished bars, each with a minimum yield strength of 100,000 psi. For highly machined parts, use C-1144. Moderately machined parts—C-1140 or C-1151. For parts where machinability is a minor factor—C-1050 or C-1045. Send for complete data.



World's Largest Producer of SPECIALTY WELDED TUBING

Challenge us to come up with a solution to your toughest tubing applications.

We will produce the best possible answer drawn from Republic's full line of quality welded steel tubing and more than 50 years of applied engineering experience.

This claim is made with confidence. Our customers regularly hand us their tubing problems, and the results have provided mutual satisfaction.

Manufactured at the Steel and Tubes Division, Republic Tubing is welded by the ELECTRUNITE® process—a continuous electric weld method which unites the wall under pressure without foreign or extra metal. Among other advantages, this process assures uniformity of wall thickness, strength, ductility, and concentricity.

Republic, the pioneer in this improved welding process, was also the first to provide a non-destructive electronic production method of testing tubing used for critical pressure applications. This is known to the trade as FARROWTEST®.

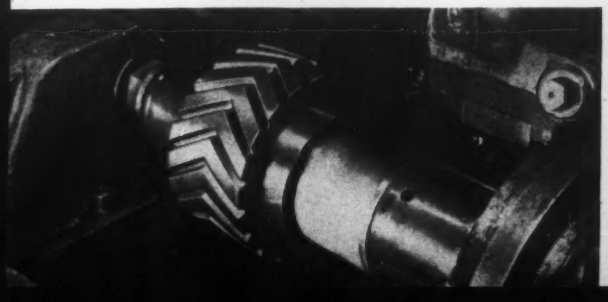
Next time you have a tubing application or problem, take advantage of Republic's prompt delivery, engineering services, and complete range of carbon and stainless steels for mechanical, structural, and pressure uses.

Call your nearest Steel and Tubes representative or contact us direct.

REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL

FOR ADDED MACHINABILITY, consider Republic Cold Drawn Leaded Alloy Steels. Leading producers of gears use Republic Leaded Alloy Steel in the manufacture of heavy-duty herringbone gears. Addition of lead increases machinability as much as 25%. Heat treating assures adequate hardness and toughness. Cost-reducing Republic Alloys are available in almost every standard analysis and many specials. Mail the coupon for information.



Check this listing of Republic Steel Tubing and Pipe. Which have possible applications in your products?

STAINLESS STEEL

Pressure Tubing

- ☐ Condenser Tubes
- ☐ Pipe—Schedule 40S
- ☐ Sanitary Tubes
- ☐ Heat Resistant
- ☐ Evaporator Tubes
- ☐ Bright Annealed
- ☐ Pipe—Lightweight Schedule 10S—5S
- ☐ Heat Exchanger Tubes

Mechanical Tubing

- ☐ Aircraft Exhaust
- ☐ Special Shapes
- ☐ Fabricating Facilities
- ☐ Polished Tubing
- ☐ Ornamental Tubing
- ☐ Clad Tubing Carbon—Stainless

CARBON STEEL

Pressure Tubing

- ☐ Boiler Tubes
- ☐ Heat Exchanger Tubes
- ☐ Hydraulic Fluid Line
- ☐ Grooved End Tubes
- ☐ Refrigerator Tubes
- ☐ Water Wall Tubes
- ☐ Superheater Tubes
- ☐ Condenser Tubes
- ☐ Evaporator Tubes

Mechanical Tubing

- ☐ Air Preheater
- ☐ Square Tubes
- ☐ Rectangular Tubes
- ☐ Special Smooth I. D. Hydraulic Cylinder Tubes
- ☐ Hot Rolled Tubes
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Cut out and send this check list for descriptive literature on Republic Tubing and Pipe applicable to your products.

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Please also send me information on:

- ☐ Republic Alloy Steels
- ☐ Republic Specialty Bolts and Nuts
- ☐ Republic Cold Finished Carbon Steel

Name_____ Title_____

Company_____

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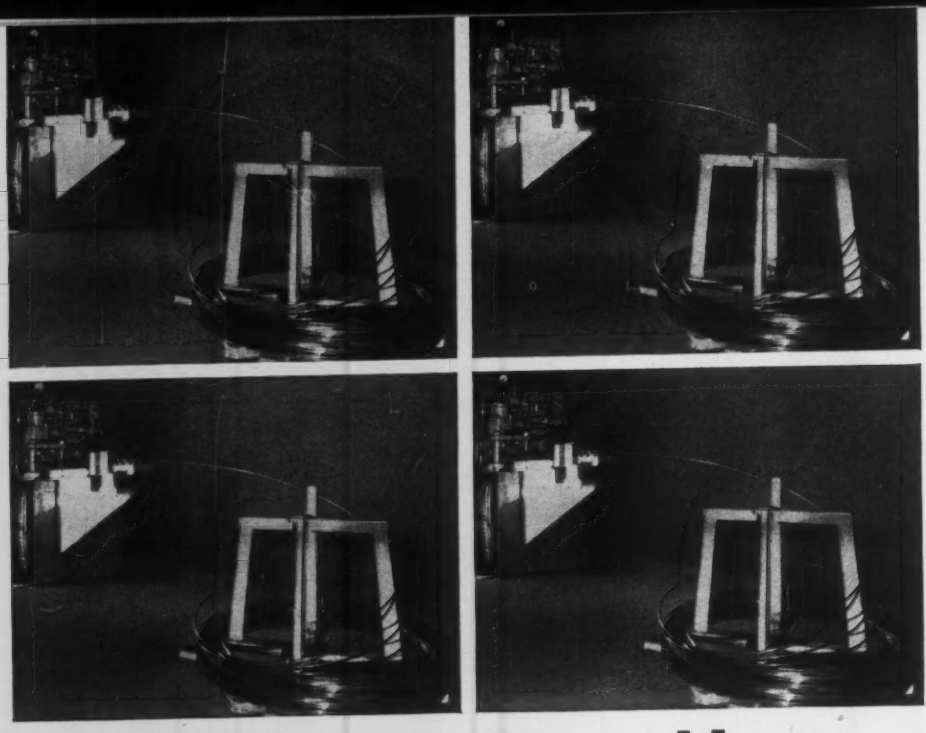
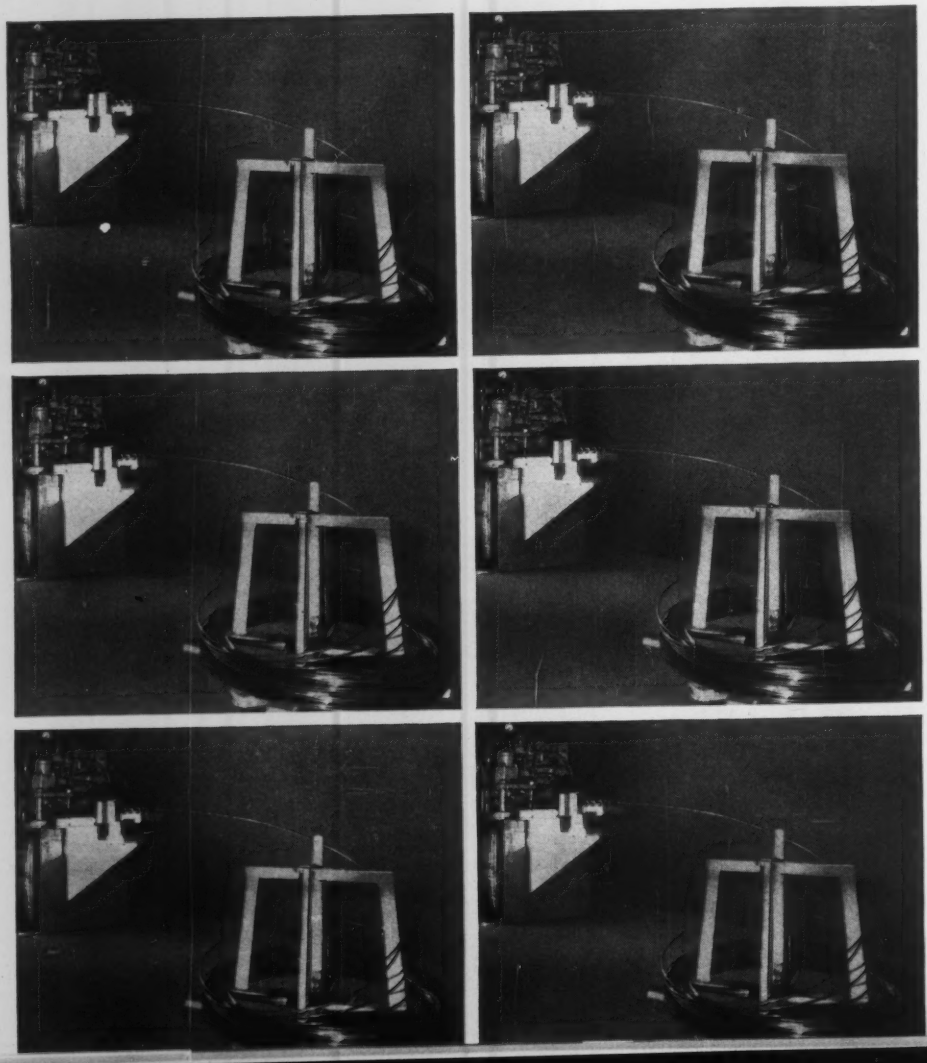
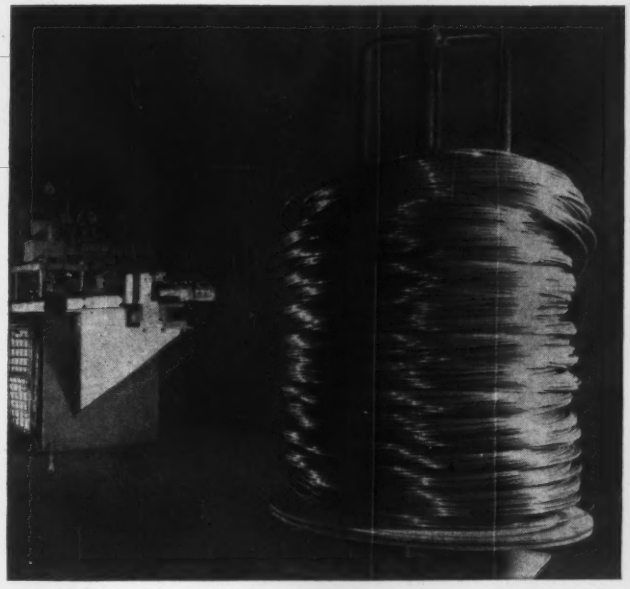
For more information, circle No. 349



Why set up ten times....





....when once will do?

It's a simple matter to add up the savings heavyweight wire coils can give you. How much time does it take you to shut down a machine and start a new coil through? Multiply that by the number of times you have to do it in an 8-hour shift. Then figure that as much as 90% of that lost time is sheer waste. Because you could be using AS&W heavyweight coils that contain up to ten times as much wire in one continuous length. **Other savings:** less handling, less storage space needed, even lower scrap loss. Heavyweight coils aren't the only road to cost reduction: *American Steel and Wire offers a dozen different wire packages.* One of them is designed just right for your operation. Let us look at your set-up and recommend the best package . . . a simple step to increased production. Call our nearest sales office or write American Steel and Wire, Dept. 1497, Rockefeller Building, Cleveland 13, Ohio.

Innovators in wire

USS American Steel and Wire Division of United States Steel

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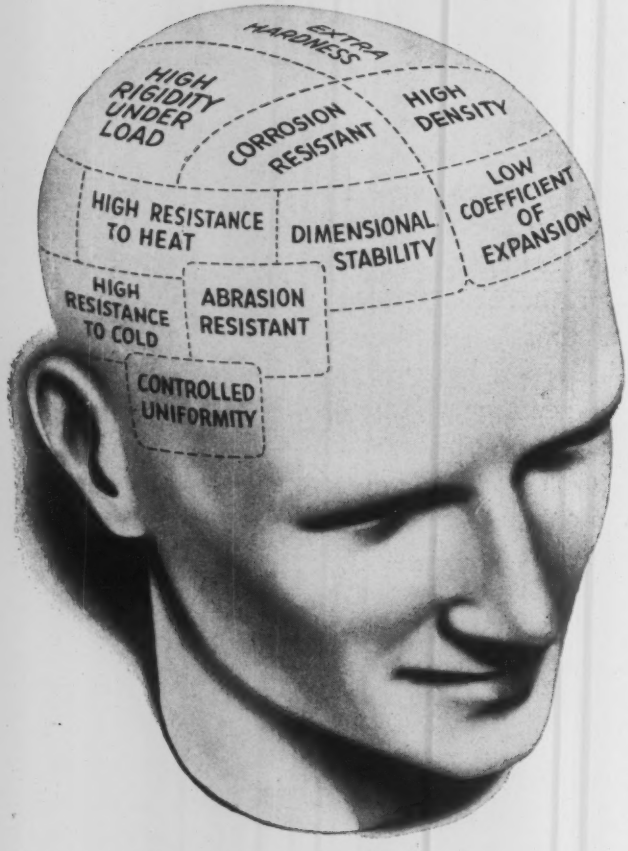
"Whatever the mind of man can conceive and believe, the mind of man can achieve..."



. . . philosophers have said it — scientists and engineers have proved it. However, unusual product ideas often require unusual metals — metals that are corrosion resistant, abrasion resistant, hold dimensional stability at extreme temperatures, have high rigidity under load or possess high density. Vascoloy-Ramet has the engineering capabilities and modern manufacturing facilities to create metals with these or any other specific physical properties that your particular product may require. Over 30-years experience in the development of carbides of the refractory metals and cast nonferrous alloys with unusual high-temperature characteristics are yours to draw from. Don't let the selection of metals block your creative efforts. Send your requirements to V-R for dependable assistance.

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NEW FROM DU PONT...
a thermoplastic "Teflon" film that's easy to fabricate

TEFLON® FEP FILM

New "TEFLON"* FEP-fluorocarbon film has nearly *all* the unique advantages of "TEFLON" TFE with one big plus. It's a true thermoplastic that can be easily formed and sealed. One type of this new film can be applied *with* adhesives, another can be laminated and heat-bonded *without* them.

Here are just some of the advantages of "TEFLON" you get in this new film • Unique antistick and low-friction properties • Chemically inert to practically all known chemicals • Electricals are high (up to 4,000 volts/mil dielectric strength) and *stay* high • Performance stays virtually constant from –250°C. to over 200°C.

"TEFLON" FEP film opens the door to whole new areas of design and product improvement. Mail coupon and start investigating "TEFLON" FEP film for yourself. (Briefly describe the end use you have in mind.)

*Du Pont trademark

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. . . THROUGH CHEMISTRY

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Film Department 9531-N (T)
Wilmington 98, Delaware

Name_____

Company Name_____

Address_____

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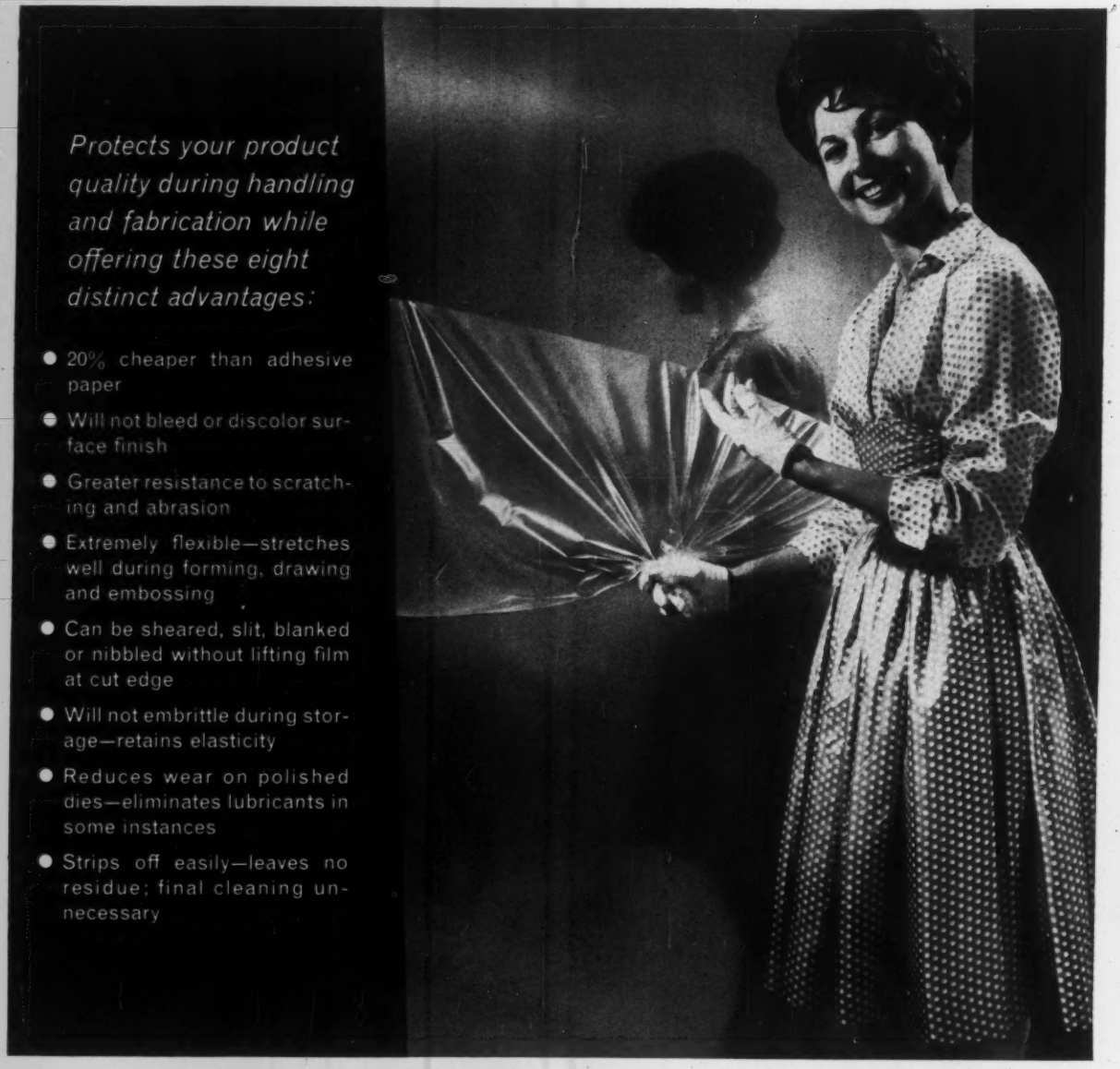
Job Function_____

Proposed End Use_____

For more information, turn to Reader Service card, circle No. 331

New strippable plastic film for protection of stainless steel surfaces



Protects your product quality during handling and fabrication while offering these eight distinct advantages:

- 20% cheaper than adhesive paper
- Will not bleed or discolor surface finish
- Greater resistance to scratching and abrasion
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- Will not embrittle during storage—retains elasticity
- Reduces wear on polished dies—eliminates lubricants in some instances
- Strips off easily—leaves no residue; final cleaning unnecessary

You get greater protection *plus* economy with the new in-fab plastic coating now being applied to MicroRold® stainless steel sheet, cut strip, and coiled sheet and strip. The semi-transparent protective film is 20% lower in cost than regular adhesive paper and offers more versatility in fabrication. The protective film is applied at our mill on customer order only, and is available on stainless steel in gages from .018″ to .050″ in widths up to 42″. It is guaranteed to strip off in one piece by loosening with fingernail at any corner.

Strippable plastic protection is intended as a safeguard only during ordinary handling, storage and fabrication—*not* as a barrier for weather, water damage, undue abrasion, impact or foreign substance. Once removed it will not adhere again.

Want more information or a test sample? Write to Product Development Dept., Washington Steel Corporation, 12-F Woodland Ave., Washington, Pa.

WASHINGTON STEEL CORPORATION

Woodland Avenue
Washington, Pa.

For more information, turn to Reader Service card, circle No. 321

Now, make your urea moldings come alive with an unmatched surface brilliance—without sacrificing quality or economy. Three new high gloss formulations make this possible: Beetle 650, designed for small parts such as closures and buttons; Beetle 625, for closures, switch plates, wiring devices and small housings; Beetle 600, for large housings and other parts requiring extended flow. These new Beetle molding compounds cure faster, and they offer improved preforming qualities. And you still have all of these dependable Beetle properties: resistance to detergents, oils and grease; arc-resistance; track resistance; good dielectric strength; surface hardness; stain-resistance; wear-resistance; unlimited range of colors. Be among the first to take advantage of this bright new development. Write for complete information today. *BEETLE — registered trademark for Cyanamid's urea-formaldehyde molding compound.

AMERICAN CYANAMID COMPANY CYANAMID PLASTICS AND RESINS DIVISION

WALLINGFORD, CONNECTICUT. *OFFICES IN:* BOSTON • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DETROIT • LOS ANGELES MINNEAPOLIS • NEW YORK • OAKLAND • PHILADELPHIA • ST. LOUIS • SEATTLE • *IN CANADA:* CYANAMID OF CANADA LIMITED, MONTREAL • TORONTO

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yours free, if you can use it

If you are one of the relatively few, highly skilled engineers in America today whose job requires a knowledge of the mysterious, highly specialized alloys used in magnetic, electronic and electrical applications, you'll want this new 64-page booklet.

In it are the two kinds of vital information about these alloys electronic designers need most today—what they will do and where you can get them, fast.

The technical data and case histories for this booklet were compiled by the metallurgical staff of The Carpenter Steel Company. They're giving you, free, the benefits of their own wide experience in producing the largest selection of these highly specialized alloys ever available from any one steelmaker.

In fact, there isn't a single Carpenter alloy mentioned in this booklet that you can't get in quantity right now.

These same skilled, experienced men are also available for work on special problems with alloys for electronic, magnetic and electrical applications.

Get your free copy of this booklet—and get in touch with the men who wrote it—by sending your request today on your company letterhead. The Carpenter Steel Company, 135 W. Bern Street, Reading, Pa.

Carpenter steel

you can make it ***consistently*** better with Carpenter Specialty Steels for specialists

Steel

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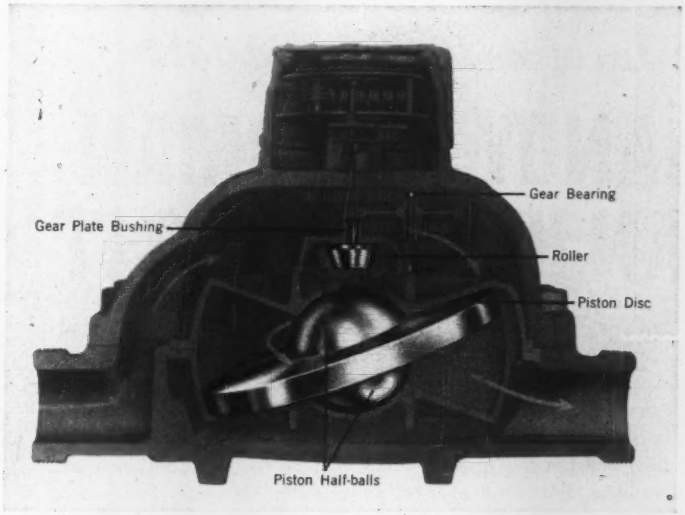
For more information, turn to Reader Service card, circle No. 411

Chemical Division 3M COMPANY



KEL-F® BRAND PLASTIC foils corrosive attack, keeps meters on the mark!

Equipment that measures even highly corrosive liquids can be enduringly exact, too! Buffalo Meter Company manufactures meters that measure precisely the flow of over 100 corrosive chemicals, including acetic acid, aluminum nitrate, carbon bisulfide, diethylamine, phosphoric acid, potassium chloride and concentrated sulphuric acid. Vital meter parts—piston discs, half balls and other components, as shown—are made of KEL-F Brand Plastic because it retains its shape and dimension in the presence of corrosive chemicals, even fuming nitric acid.

Other properties which led to the selection of KEL-F Plastic for this application include stability, easy moldability, low cold flow, low specific gravity and good lubricating qualities. The five meter components of KEL-F Plastic are molded for Buffalo Meter Company by Resistoflex Corp., Roseland, N.J., and the Garlock Packing Co., Palmyra, N.Y.

Now, new KEL-F 81 Plastic incorporates many property advantages, along with better-than-ever uniformity and consistency. For more information, read the "profile" to the right, then return the coupon below.

Chemical Division, Dept. KAR-121
3M Company
St. Paul 6, Minn.

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about KEL-F 81 Plastic

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Properties Profile on KEL-F® 81 PLASTIC BRAND

KEL-F 81 Plastic is a fluorocarbon plastic, a thermoplastic resin formed by the homo-polymerization of chlorotrifluoroethylene. The high degree of fluorination of KEL-F 81 Plastic is responsible for its chemical inertness and thermal stability. The inclusion of chlorine in an otherwise carbon-fluorine molecule results in exceptional moldability and mechanical toughness.

Crystallinity. KEL-F 81 Plastic is crystallizable, but not necessarily crystalline, the degree and kind of crystallinity in a given sample being a function of its thermal history. The "quick-quenched" resin is spoken of as amorphous, and the "slow-cooled" resin as crystalline. When crystalline, KEL-F 81 Plastic is a denser, more translucent material with higher tensile modulus, lower elongation, and greater resistance to the penetration of liquids and vapors. The amorphous plastic is less dense, more elastic, with greater optical clarity and toughness.

Physical Properties. The physical properties of KEL-F 81 Plastic combine mechanical, chemical, electrical, and optical advantages. And the most useful applications center around combinations of the following properties:

1. Useful temperature range: from —400° F. to +400° F.
2. Resistance to deformation and flow at high temperatures, pressures
3. Zero moisture absorption
4. Abrasion resistance
5. Radiation resistance
6. Chemical resistance
7. Electrical properties
8. Infrared transmission
9. Inert to liquid oxygen
10. Flexible in contact with cryogenic fuels

Processing. KEL-F 81 Plastic can be processed in the same manner as other thermoplastic resins. Parts of KEL-F 81 Plastic may be specified in any form.

Detailed data on physical properties is contained in a new free brochure. For your copy, return coupon or write to 3M Chemical Division, stating area of interest.

"KEL-F" is a reg. TM of 3M Co.

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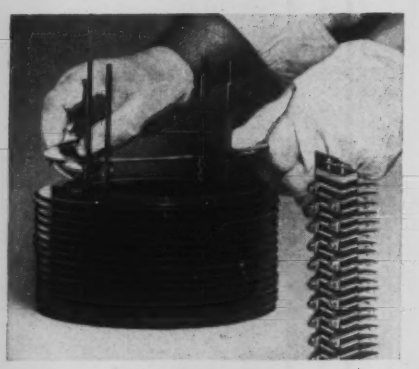
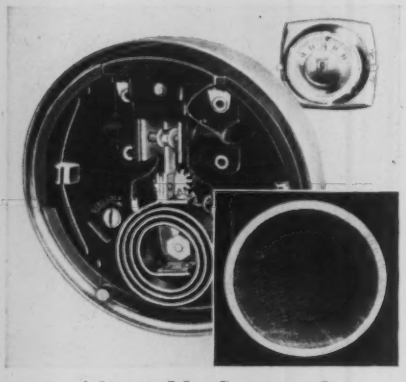


Slip Rings?

To provide excellent electrical properties and long equipment life for slip rings, we manufacture and supply fine and coin silver in the form, size, finish and degree of hardness most convenient for the manufacturer and least productive of scrap.

Photo courtesy of Breeze Corporations, Inc., Union, New Jersey



Adjustable Contacts?

The Handy & Harman Bimet shown here is used as an adjustable contact in a Rimset thermostat for control of residential heating, cooling and air conditioning. It is made of fine silver for optimum conductivity and reliability, and clad with bronze to give a more machinable, easily threaded surface. Handy & Harman bimetals give you uniformly clad precious metal just where you need it, with no excess. Available in gold and silver and their alloys in strip, overlays, inlays, edge lays and thrulays.

Photo courtesy of Penn Controls, Inc., Goshen, Indiana

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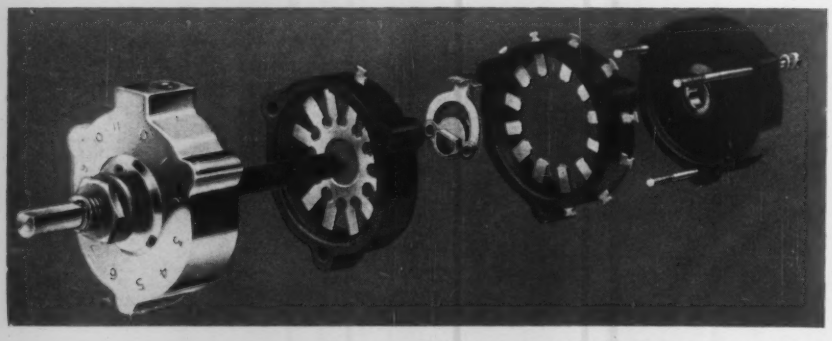


Rotary Switches?

Low contact resistance and ability to withstand corrosion make silver ideal for switch parts. The stationary contacts of this rotary switch are made of fine silver...the multiple leaf brushes are of durable silver alloy. Life tests of one million operations, representing several years of normal use, show that "Zero" resistance of 0.001 ohm through the switch body changes by less than 0.0005 ohm.

Photo courtesy of Leeds & Northrup Company, Philadelphia, Pa.

For more information, turn to Reader Service card, circle No. 412

Superconducting magnets made of columbium-tin wire appear to be a likely development, based on recent tests. Wire made of this material (Cb_3Sn) is reported to remain superconducting in pulsed magnetic fields of up to 185 kilogausses. Extrapolation to zero measuring current indicates a critical field of about 188 kilogausses at 1.6 K.

Source: National Bureau of Standards, Washington 25, D.C.

Small visual furnace for classroom and laboratory demonstrations rises to 6000 F in 3 sec and cools very rapidly. Specimens rest directly on a graphite cloth heating element. The fast cooling rate and noncontaminating quality of graphite may also permit production of extremely pure alloys and semiconductor materials without removing melts from the furnace for cooling.

Source: Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.

Bare aircraft wheels with 2014-T6 aluminum alloy rims are being installed on B-58 bombers to carry the plane's weight in the event of a tire failure. These shatter-proof auxiliary wheels are larger than the tire wheels and are mounted between each pair of the plane's tires. The new wheels were developed to prevent steel tire wheels from riding on the ground, shattering, and throwing fragments into the fuel tanks.

Source: Goodyear Tire & Rubber Co., Akron 16, Ohio.

Coating thousands of semiconductors at once with a glass film 0.1 mil thick is said to increase reliability and reduce cost of protective sealing. Film is formed by applying a glass powder to oxide-coated silicon wafers that hold thousands of semiconductors, and then firing at about 1500 F. Electrical contacts are made through holes etched in the glass.

Source: International Business Machines Corp., P. O. Box 390, Poughkeepsie, N. Y.

Magnesium baseball bat, said to take the sting out of slugging, went through some major league tryouts last season. Most players comparing the bat with those made of wood were unable to distinguish any difference in performance. The experimental bat, which has a plastic covering, is said to far outlast the traditional wooden bat, and to be more uniform in weight.

Source: Newark Processing Co., Inc., 160 Everett Ave., Newark, Ohio.

Automotive gear, molded from two reinforced phenolics in one shot, is now under evaluation. Proposed as a timer sprocket, the part uses a nylon-reinforced phenolic compound in the periphery to give teeth wear resistance and resilience. The hub area is molded of a glass-reinforced phenolic for rigidity. Design objectives are lower cost, quieter operation and longer life.

Source: Hooker Chemical Co., Niagara Falls, N. Y.

Flux-free joining of aluminum to stainless steel has been reported, eliminating flux occlusions which destroy joints through electrolytic action. The new procedure: tin the stainless steel with 50Pb-50Sn solder, tin the aluminum with Sn-1Ag-0.01Al-0.01Cu-1Fe-1Pb-0.1Si, then place these two surfaces together and heat to 500-600 F with an oxyacetylene flame.

Source: U. S. Dept. of Commerce, Washington 25, D. C.

The rich look of wrought iron, yet Westmoreland's new fencing is . . .

GUARDED BY GALVANIZED STEEL

You're looking at an attractive new idea in fences from Westmoreland Metal Manufacturing Company of Philadelphia. It's a steel fence made of square tubing which duplicates the traditional appearance of wrought iron. But it costs less and virtually eliminates maintenance problems.

It's made of galvanized steel, which means lasting protection from the punishing whims of Old Man Weather. Come rain, come snow, the zinc coating stays on guard for keeps. Galvanized steel also helps hold down the price of this fence because of its low initial cost and the ease with which it can be formed into desired shapes.

WEIRKOTE® IN PARTICULAR! The galvanized steel used in this new fence line is National Steel's Weirkote. To the inherent strength, economy and versatility of steel, Weirkote adds enduring zinc protection via the modern continuous process. As a result, Westmoreland president, Irving H. Kutcher, reports: "Weirkote comes through our fabricating operation without any harm whatsoever to its protective zinc coating. We never have to worry about chipping or peeling." Weirkote is manufactured by two National Steel Corporation divisions, Weirton Steel and Midwest Steel. Write Weirton Steel, Weirton, West Virginia, for further details.

MIDWEST STEEL
Portage, Indiana

WEIRTON STEEL
Weirton, West Virginia

Divisions of
NATIONAL STEEL CORPORATION

For more information, circle No. 362

This month we present staff reports on

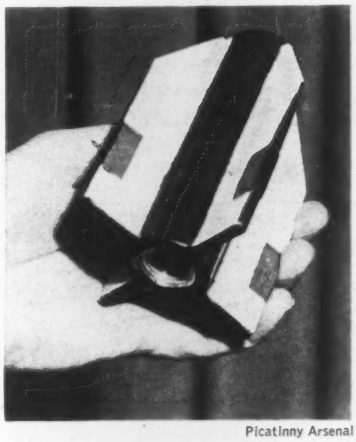
2

IMPORTANT MATERIALS SYMPOSIUMS

The first starts on this page; the second, on aerospace materials, begins on p 94

1. Adhesive Bonding: State of the Art

by Malcolm W. Riley, *Associate Editor, Materials in Design Engineering*



Picatinny Arsenal

Epoxy adhesive *solved this tough bonding problem joining TFE fluorocarbon fins to aluminum body.*

A well-defined science is emerging from the hitherto relatively unorganized art of structural adhesive bonding: this is the single most vivid impression gained at a recent symposium on adhesive bonding sponsored by the U.S. Army Ordnance Corps at Picatinny Arsenal.

Unlike many technical symposiums, it was not a meeting of materials suppliers discussing proprietary developments. It was a meeting of top research, development and engineering people discussing objectively the state of the art . . . or the science. Altogether, more than 200 engineers and materials men of the Ordnance Corps and its contractors heard a score of authorities in the field discuss 1) new developments in adhesive materials, 2) parameters for adhesive selection, 3) how to design for maximum efficiency in adhesive joints, and 4) special applications for adhesive bonding. Here is a summary of what they said . . .

Materials: high temperature the keynote

Discussing the future potential of adhesives, *G. Epstein* of Aeronutronic, Div. of Ford Motor Co., characterized the present performance limitations of high temperature adhesives as shown in Fig. 1. At present we are limited to a temperature of about 500 F for relatively short exposure periods. Further, the need for high temperature adhesives exists not only in the somewhat limited military applications, but also in the commercial area where multi-Mach passenger planes are now on the drawing boards (at Mach 3, for example, skin temperatures reach 1000 F at sea level; 650 F at 30,000 ft).

Development efforts in organic adhesives are aimed at long-time capability at 500-600 F, short-time capability at possibly 1000 F. Inorganic adhesive development is aimed at long-time capability at 1000 F and higher temperatures.

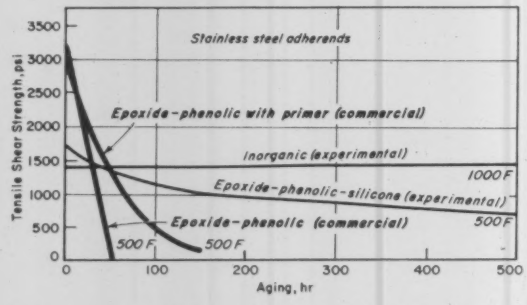
Organics still promising

In summarizing the status of high temperature organic adhesives, *H. H. Levine*, of Narmco Research and Development Div., emphasized the lack of test methods for predicting long-term (e.g., five years) performance. High speed jet aircraft and space stations, expensive to build, must be long-lived. At present, there is no effective accelerated test method for predicting stability of adhesives over such long periods.

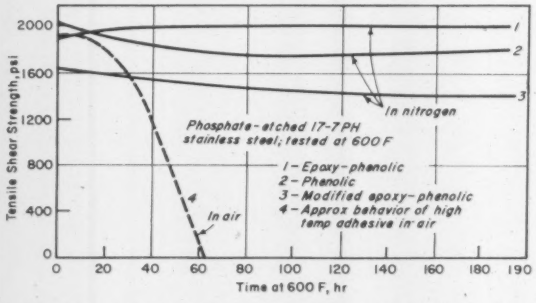
A complicating factor is the lack of knowledge as to the part played in degradation at high temperatures by thermal effects, and that played by oxidation. The importance of oxidation can be seen in Fig 2, which shows the stability of five adhesives when exposed to 600 F in nitrogen as opposed to the rapid degradation of a typical high temperature adhesive in air.

Levine went on to summarize the status of development of adhesives for four types of high temperature service:

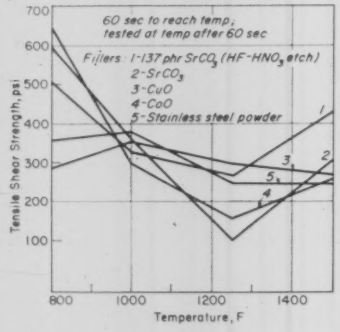
1. Short time (<2 min) at >1000 F—At temperatures of



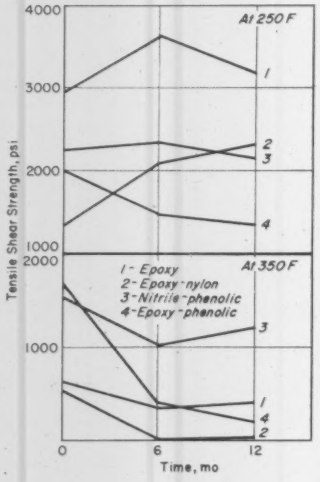
1 *Present capabilities and current experimental work in heat resistant adhesives*
(according to F. H. Bair in "Adhesives Age," Feb '59).


In nitrogen
Phosphate-etched 17-7 PH stainless steel, tested at 600 F
1 - Epoxy-phenolic
2 - Phenolic
3 - Modified epoxy-phenolic
4 - Approx behavior of high temp adhesive in air
In air
Tensile Shear Strength, psi
Time at 600 F, hr

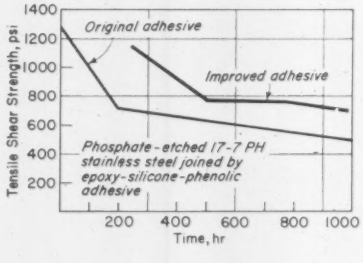
2 *Effect of heat aging on tensile shear strength of five adhesive bonds in nitrogen vs approximate behavior in air.* (Levine)



3 *Effects of rapid heating on a commercial phenolic adhesive with various fillers.* (Levine)



4 *Effect of aging at 250 and 350 F on four adhesive systems.* (Levine)



5 *Effect of aging at 500 F on both original and improved epoxy-silicone-phenolic systems.* (Levine)

1200 to 1500 F with rapid heat-up, thermal energy alone is sufficient to cause rapid degradation of the polymer system.

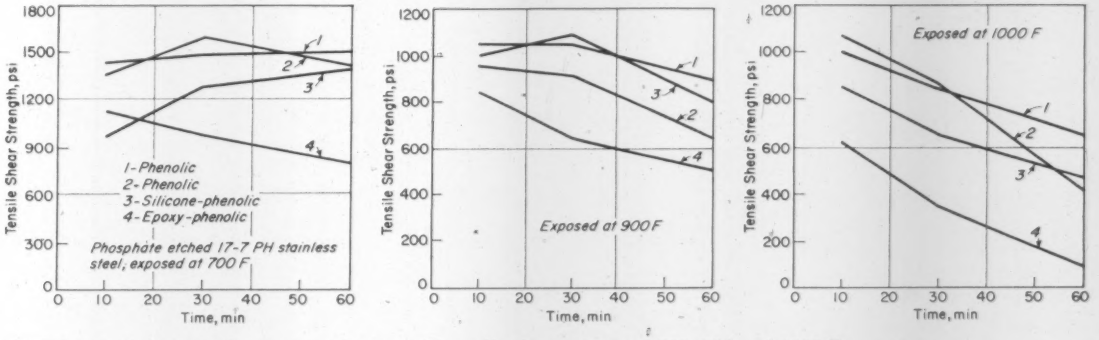
One phenolic adhesive system selected from previous evaluations was tested after brief exposure at high temperatures (60 sec to reach temperature; tested after 60 sec at temperature) to determine short-time capabilities above 1000 F. Tests were carried out using various types of fillers. Although tensile shear strengths were relatively low at 1500 F, as shown in Fig 3, the results were promising considering that the adhesive evaluated was a commercial system. An interesting (and perplexing) phenomenon is the "knee" in the curve for each formulation at about 1250 F; here strengths improve, or at least degradation of the adhesive is retarded.

2. Very long time (1 yr) at <500 F—At present, the potential for structural adhesives having useful lives of 30,000 hr and upward, according to Levine, is "pretty grim." The primary problem is how to predict performance over such a period of time.

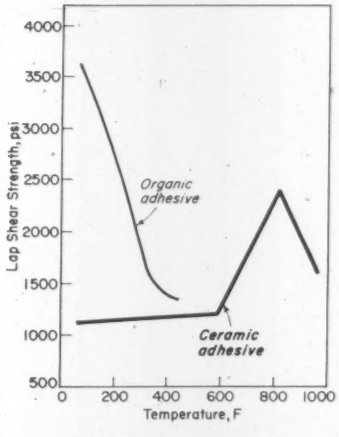
Results of a projected five-year exposure test at 250 and 350 F at Narmco were reported. After 12 months, the prospects are poor at 350 F, but better at 250 F, as shown in Fig 4. (L. R. Lunsford, of General Dynamics-Fort Worth, pointed out that the extensive nitrile-phenolic type of adhesive bonding used in the B-58 Hustler is designed to withstand 260 F aerodynamic heating and has performed exceptionally well.)

The testing picture is further complicated, of course, by the fact that in service, exposures are not continuous but intermittent.

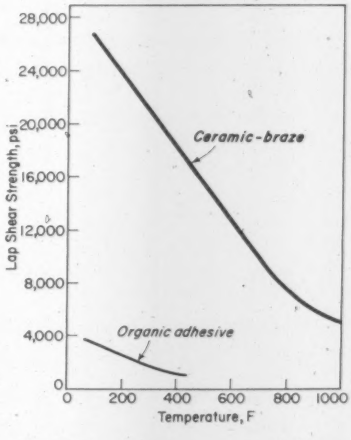
3. Long time (1000 hr) at 500 F—Disappointing results have been obtained with the 422 epoxy-phenolic type 500 F adhesive when used on stainless steel instead of aluminum. An epoxy-silicone-phenolic adhesive was developed by Narmco which successfully adhered stainless steel to itself for 1000 hr at 500 F. Cured with arsenic pentoxide the adhesive is semi-organic in nature. Effects of 1000-hr exposure at 500 F on the first such adhesive, as well as a



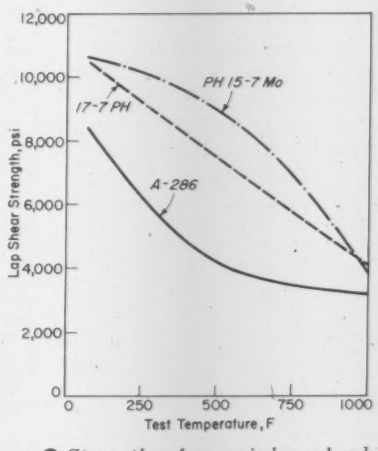
6 *Effects of exposure for up to an hour on four adhesive systems at 700, 900 and 1000 F.* (Levine)



7 *Typical of ceramic adhesives is the increase in strength with increasing temperature.* (Whitney)



8 *Effect of heat on ceramic-braze composition.* (Whitney)



9 *Strengths of ceramic-braze bonded joints in three high temperature alloys tested at temperature.* (Whitney)

newer developmental type, are shown in Fig 5.

4. Short time (1 hr) at 700-1000 F—The best commercial adhesives were tested at 700-1000 F, for periods of 10, 30, and 60 min in air, on 17-7 PH stainless steel. Results indicate that purely organic adhesives can do surprisingly well on steel for up to 1 hr at 1000 F, as shown in Fig 6. The exceptions were epoxy and blended epoxy adhesives which were eliminated from further evaluations because of their poor performance.

Ceramics for 1000 F plus

Although they must still be classed as developmental, structural ceramic adhesives hold out the greatest promise for service temperatures of 1000 F and above. As *J. W. Whitney*, of Boeing Co.'s Wichita Div., pointed out, one of ceramics' distinguishing characteristics is their increase in strength with increasing temperatures. Fig 7 compares the basic strength-temperature relationship of a ceramic adhesive with that of a typical organic adhesive.

Whitney also pointed out that the brittleness of ceramic adhesives need not be too limiting a factor, as evidenced by the widespread acceptance of ceramic coatings. The major importance of brittleness, apparently, is that it is a different sort of behavior from that to which the adhesive technologist is accustomed.

A recent development at Boeing-Wichita is the use of ceramic adhesive-brazing alloy combinations to eliminate the need for vacuum and/or protective atmospheres and to simplify procedures in brazing superalloys. Two systems being investigated under Air Force sponsorship are 1) silver-base brazing alloy (800 F maximum use temperature) in either foil or powder form combined with ceramic for bonding 17-7 PH and PH 15-7 Mo for the B-70 bomber, and 2) nickel-base brazing alloy (1500 F maximum use temperature) in powder form combined with ceramic for higher temperature bonding.

A typical lap-shear strength vs temperature relationship is shown in Fig 8. Values for bonded A286, 17-7 PH, and PH 15-7 Mo alloys are shown in Fig 9.

Other types of ceramic adhesives under development include air-setting cements, devitrified ceramic adhesives, and exothermic ceramic-metal adhesives.

Adhesive selection: design, evaluation, processing

Discussions of adhesive selection stressed the importance of 1) selecting an adhesive whose capabilities will result in maximum joint efficiency (i.e., failure will occur in the adherends), 2) evaluating effects of specific anticipated service conditions on adhesive performance, and 3) selecting proper processing conditions and holding close control over processing, all the way from preparing the adherends through final inspection.

Match performance to design

According to *N. J. De Lollis*, of Sandia Corp., structural adhesives can be generally classed as 1) hard, brittle adhesives with high shear and tensile strengths but low peel strengths (e.g., epoxies), and 2) more ductile types with high peel strengths plus high shear and tensile strengths. To select the proper adhesive the stress configuration in the joint must be analyzed carefully to determine the type of loading the adhesive must withstand.

The first adhesive type generally requires only contact pressure during assembly and cure, and may be cured at temperatures ranging from room to 350 F, depending on the hardener. Major limitations lie in the low peel strengths which are only a few pounds per inch.

The second type usually requires temperatures of 300 to 350 F and pressures up to 200 psi for 60-90 min for proper cure. Peel strengths may range upward from 72 lb per in. of width.

De Lollis went on to describe the analysis of a particular bonding application and the selection of a specific adhesive. The analysis proved valid when, under test, failure occurred in the adherend.

Evaluate against environment

Both the importance of testing an adhesive in the particular environment for which the joint is intended, and the inadequacy of present accelerated testing procedures, were emphasized strongly by *R. F. Blomquist* of Forest Products Laboratory. Permanence of a particular adhesive under conditions such as moisture, sunlight, heat and cold is difficult or impossible to predict at present, he said.

Blomquist stressed the need for research aimed at determining fundamental mechanisms and kinetics of deterioration of adhesives. He said that, "Often it has been difficult or impossible to determine whether physical or chemical changes are involved in observed deterioration of bonds." Such basic work would both point the way to development of new, more durable adhesives, and help in developing meaningful accelerated permanence tests that would really simulate actual service conditions.

Current work in developing accelerated tests consists largely of boiling bonded wood specimens in water for 48-72 hr or steaming

EFFECT OF PRETREATMENT ON STRENGTH OF ADHESIVE BONDED JOINTS
(Vinyl-Phenolic Structural Adhesive)

Metal and Treatment[a]	Average Shear Strength, psi
Aluminum	
As Received	2442
Degreased	2741
Treatment A	5173
Treatment A[b]	3621
Stainless Steel	
As Received	5215
Degreased	6306
Treatment A	7056
Titanium	
As Received	1356
Degreased	3180
Treatment A	6743
Magnesium	
Treatment B	3842

[a]Treatments: A—Sulfuric acid-sodium chromate bath, followed by washing in distilled water; B—Detergent washing followed by immersion in chromic oxide solution.
[b]Treatment after panels were oven-dried.
Source: *Thelen.*

them at atmospheric pressure for 4-8 hr. But how applicable or reliable such tests will be for new wood adhesives or different chemical types remains to be established.

Nondestructive tests should be highly useful for measuring change in joints during exposure periods. However, at present, ultrasonic testing techniques can only determine whether a joint exists—not how strong it is.

Control processes closely

All elements of processing adherends and adhesives must be controlled closely to obtain optimum bonds. From the standpoint of the designer, proper preparation of adherends is probably the most pertinent of all process controls.

The direct relationship between strength and permanence of adhesive bonds and the type and degree of surface preparation was graphically shown by *E. Thelen* of Franklin Institute Laboratories. The accompanying table compares average shear strengths of bonds between various metals when the metals are variously pretreated.

An important overall impression gained from Thelen's discussion was that though many of the basic mechanisms whereby pretreatment improves adhesion are only partially understood, substantial progress in such understanding is being made. And much work is still going on.

Although the specific type of pretreatment best suited for each type of metal depends on the metal and the adhesive to be used, Thelen summarized that proper surface preparation may be necessary to 1) remove oil, dirt and dust, 2) control adsorbed water, 3) control oxide formation or obtain favorable oxides, 4) deposit chromium atoms or titania to promote adhesion, 5) poison iron or other surface atoms that catalyze polymer breakdown, 6) protect the adherend from corrosive effects of the adhesive, and vice versa, 7) match adherend crystal structure to adhesive molecular structure, and 8) control surface roughness.

Design: aim for maximum efficiency of bonded joints

The fact that maximum efficiency of bonded joints can only be obtained by designing the joint specifically for adhesive bonding has been stressed before. Though much of adhesive joint design in the past has been empirical, rational bases for future theoretical design approaches are being laid. In fact, successful theoretical designs can now be made using a sophisticated stress analysis approach. This was described by De Lollis (see above), as well as by Wegman, Bodnar, and Taglier (see "How to Design for Adhesive Bonding," M/DE, Aug '61, p 120).

B-58: the flying glueline

The B-58 Hustler has the lowest structural-weight-to-gross-weight ratio of all airplanes the Air Force flies today. This could only be accomplished by extensive use of adhesive bonding (about 4500 sq ft of bonded paneling per airplane, using over 900 lb of adhesives).

L. R. Lunsford, of General Dynamics-Fort Worth, described in some detail the empirically developed designs of the bonded structures of the airplane. He also outlined a theoretical method of predicting joint strength that is now under development.

The method involves developing mathematical expressions for the three basic types of bonded joints employed. Use of the expressions requires determining true shear strength and shear modulus of the adhesive. To obtain these data, a specimen simulating the torque loading of a large diameter, thin walled tube has been developed. By carefully measuring the rotational deflections within the elastic range of the adhesive, shear modulus can be determined.

Work on this theoretical method is continuing in close coordination with the pertinent committees of the American Society for Testing and Materials.

Other Noteworthy Papers

Other papers of interest to engineers and materials men included the following:

Stress analysis: Methods of determining stress distribution in adherends and adhesives were outlined by K. F. Hahn and D. F. Fouser of Douglas Aircraft Co. Mathematical equations were developed and results were proved experimentally by use of photoelastic stress analysis.

Peel testing: The property "peel strength" was defined by S. Yurenka, of Narmco Industries, Inc., as the area under the tensile stress-strain curve of the adhesive. But the actual tensile stress reached in the root of the peel failure is a notched tensile stress. Thus, Yurenka pointed out, if a simple notched tensile test for adhesives could be developed it would quickly replace all other present peel tests.

Printed circuits: An overall picture of printed circuitry with emphasis on selection of adhesives and testing for durability was presented by D. K. Rider of Bell Telephone Laboratories. The problem of possible corrosion of copper by the adhesive was described and a simple test for determining corrosivity was outlined.

References

This summary article is based on the following papers presented at an Adhesives Symposium sponsored by the U.S. Army Ordnance Corps at Picatinny Arsenal, Dover, N.J., on Sept 27 and 28, 1961:

Blomquist, R. F., "Importance of Evaluation of Adhesives for all Environmental Conditions and Permanence Studies."

DeLollis, N. J., "Structural Adhesives Characteristics and Application."

Epstein, G., "Potential of Adhesives for the Future."

Hahn, K. F., and Fouser, D. F., "Methods for Determining Stress Distribution in Adherends and Adhesives."

Levine, H. H., "Recent Developments in High Temperature Adhesives."

Lunsford, L. R., "Design of Bonded Joints."

Rider, D. K., "Adhesives in Printed Circuit Applications."

Thelen, E., "Adherend Surface Preparation."

Whitney, J. B., "High Temperature Ceramic Adhesives."

Yurenka, S., "Metal Adhesive Peel Testing."

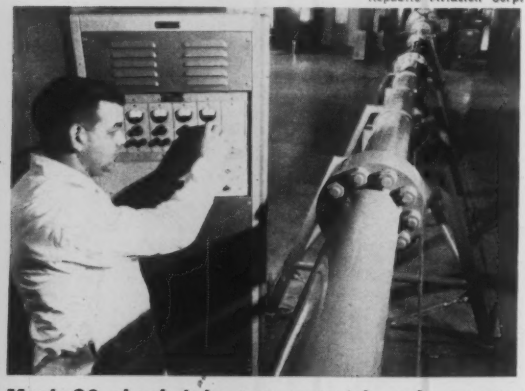
2
IMPORTANT MATERIALS SYMPOSIUMS

2. Aerospace Materials: Where We Stand Today

by Robert J. Fabian, *Associate Editor, Materials in Design Engineering*

Over 1200 of the country's top materials men attended a recent Air Force Materials Symposium to hear state-of-the-art reports on new materials developments and problems. Out of this meeting—one of the most comprehensive materials meetings ever held—have come 50 papers which on the whole should be "required reading" for all engineers involved in space and other high temperature projects. Here, our editor who attended the symposium gives the highlights and summarizes some of the newest information.

Republic Aviation Corp.



Mach 20 shock tube *tests materials under reentry conditions at speeds up to 15,000 mph.*

CERAMICS AND INTERMETALLICS: A LOOK INTO THE FUTURE

A large number of ceramics and intermetallic materials look promising for new applications. In future years you can expect to hear more about:

Borides. This group of refractory ceramics is composed of 30 binary borides with melting points greater than 3600 F, plus mixed borides and ternary materials. They appear to be the only materials that can support substantial loads under oxidizing conditions over a temperature range of 2900 to 4000 F.

Beryllides. Although not being used now, they have excellent potential where high strength-to-weight ratio and resistance to oxidation and thermal shock are needed. Typical applications proposed are leading edges, wing and body panels, nose cone skirts and bearings. They cannot be used over 2800 F in a high vacuum. At present it appears that through mechanical working lower density beryllides will attain a modulus of rupture of 40,000 psi at 2750 F. High density beryllides may reach 72,000 psi at 2750 F.

Carbides. These materials have high melting temperatures plus high hardness, good abrasion resistance and reasonable strength at moderately high temperatures. Tests show silicon carbide's flexural strength is practically unaffected to 2730 F and can go as high as 70,000 psi. Flexural strength of chromium carbide increases from 43,000 to 80,000 psi at 2010 F but decreases sharply at higher temperatures. Boron, zirconium and titanium carbides behave in a similar way.

Nitrides. Refractory nitrides such as those of boron, aluminum and silicon are commercially available, but except for silicon nitride, none can be recommended unequivocally above 2000 F because of oxidation attack. The most important structural nitride appears to be boron nitride, whose strength is somewhat higher than graphite's at room temperature. Its strength drops in the 1800 to 2700 F range but rises again at higher temperatures.

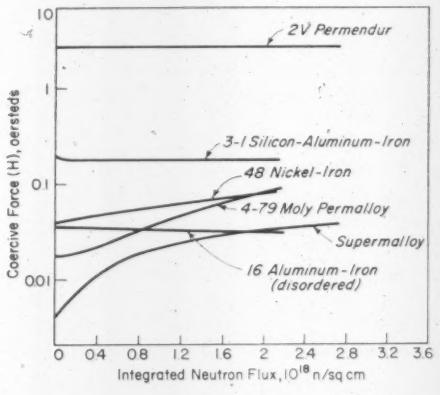
Silicides. Silicides are noted for oxidation resistance and strength at high temperatures. Tungsten disilicide has a modulus of rupture close to 70,000 psi at 2750 F. Also, a combination of 90% zirconium diboride and 10% molybdenum disilicide has excellent oxidation resistance up to 3450 F.

Refractory oxides. These materials have outstanding chemical stability over a wide temperature range, especially under oxidizing conditions. Steady improvements in properties will be made but it appears doubtful that unmodified oxides will be useful as structural materials. However, they will continue to be important for low stress applications where good thermal or electrical properties are needed.

IRRADIATION, HEAT AFFECT SOFT MAGNETIC MATERIALS

Preliminary investigations at the U. S. Naval Ordnance Laboratory show that the softest (i.e., lowest coercivity) magnetic core materials are those most drastically affected by neutron irradiation and high temperature.

Magnetic core materials undergo an increase in coercivity when imperfections are introduced in the crystal lattice during neutron irradiation. On the other hand the "structure insensitive" properties of soft magnetic materials are generally unaffected by neutron irradiation. Core materials with coercive forces greater than 0.5 oersted are essentially undamaged. However, the relatively low permeability of these materials can restrict their use. Typical effects of irradiation on several materials are shown in the graph.



Investigators have also learned that irradiation of nickel-iron alloys in the presence of a magnetic field can produce a square hysteresis loop in the material which increases its residual induction but also increases coercive force. It has also been established that irradiation increases the high frequency losses of metal powders but, because of stress relief effects, it generally has less effect on powders than on sheets and tapes.

High temperature oxidation is proving to be a serious problem with some soft magnetic materials and can have a bad effect on iron-cobalt alloys. However, when used in a neutral atmosphere they can remain stable as high as 1100 F.

A large number of soft magnetic materials have to be used at lower temperatures because their Curie temperature is too low. Nickel-iron alloys, for example, reach their Curie point as low as 840 F.

Irreversible changes in the magnetic properties of many core materials can also be produced by thermal cycling. Supermendur, for example, is affected by cycling and grain-oriented materials show degradation of magnetic properties at high temperature.

MANY COATINGS CAN CONTROL TEMPERATURE

Many inorganic and organic coatings are proving successful in controlling the temperature of space vehicles.

Metallic coatings generally absorb little solar energy, but emit infrared energy even less. For example, aluminum which absorbs 12% of solar energy but only emits 3%, can reach a steady state temperature of 250 to 300 F (ignoring heat absorbed from the earth). Thus, uncoated aluminum and almost all metals have a high absorption-emittance ratio and must usually be treated to reduce their temperature. This can be done by:

- Sandblasting.
- Coating with a material that is transparent to solar energy but is emissive to infrared energy (e.g., stripes of inorganic alumina or organic white enamel).
- Combining metals with organic coatings to get a compromise in properties. For example, an aluminum-silicone coating has an absorption-emittance ratio of about 1.3.

A big problem with using highly reflective metals is that many of them are badly affected by oxidation. No reflective metals except gold, rhodium and platinum can be used without a protective overcoat. Unfortunately, even gold readily diffuses into all base metals above 600 F. Air Force coating specialists emphasize that this diffusion is a serious problem and that "a major effort in research is needed to obtain methods of retarding diffusion with substrate materials."

Organic coatings almost all have very high emittance because of their absorptivity in the infrared range. Thermal properties can be adjusted by pigmenting with materials such as aluminum leaf, white lead carbonate, zinc sulfide, rutile, carbon black and oxides. Thus, coatings can be provided with an absorption-emittance ratio of 1 or less to provide cool surfaces in space.

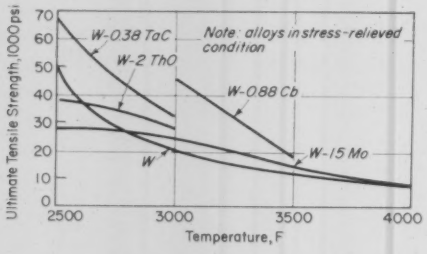
Inorganic coatings such as anodized and ceramic coatings are quite absorptive in the infrared range, but less absorptive than most organic coatings. Ceramics can be used alone to reduce temperature; however, they are said to be more effective as pigments in inorganic coatings to increase reflectance. Ceramic coatings are generally inferior to organic coatings because of their lower absorption-emittance ratio, poorer mechanical properties, and relative difficulty in application. However, they can withstand higher temperatures.

Work is now underway to improve the emittance of anodized coatings by incorporating high temperature dyes or pigments. Anodized coatings are also being developed that have a ratio of solar absorption to long wavelength emittance of less than 0.2.

STRONGER TUNGSTEN ALLOYS ARE IN THE OFFING

To date, development of tungsten alloys has centered around alloys produced by powder metallurgy and by consumable electrode arc melting. Arc melting is said to be more versatile in that it permits production of more alloy systems. However, it is limited somewhat in that during production alloying elements become volatile and are difficult to retain.

In general, development of tungsten alloys has been held back because of difficulty in preparing the alloys and because of limited high temperature testing capabilities. Except for other refractory metals, most alloying elements tend to dilute tungsten but they are advantageous because they permit strain hardening. However, above 3000 F (the temperature range where tungsten will be competitive as a structural material) strain hardening is not effective because of recrystallization and additions of inert dispersed particles will probably be the most important strengthening method for tungsten alloys.



Of the various tungsten materials shown in the accompanying graph the only one that is commercially available in sheet form is unalloyed tungsten. However, considerable interest now centers around the tungsten-molybdenum alloys. Although molybdenum does not provide added strength over 4000 F, the tungsten–15% molybdenum alloy is superior to unalloyed tungsten at temperatures below 4000 F.

Improvements in strength at 3000 F have also been obtained with small additions of Group Va elements such as columbium and tantalum. In fact, one alloy containing only 0.57% columbium has an ultimate tensile strength of 60,000 psi at 3000 F. This level is not duplicated with similar alloys and, although the strengthening mechanism is not completely understood, it seems likely that it is partly related to the processing method used.

A number of interesting experimental solid solution alloys have recently been developed based on the tungsten-tantalum-molybdenum-columbium series. One tungsten–5.7 molybdenum–5.7% columbium alloy has an ultimate tensile strength of 62,000 psi at 3000 F. Other tungsten and tungsten-tantalum alloys in the series have reached strength levels above 50,000 psi.

MAJOR PROBLEMS IN JOINING REFRACTORY METALS

Some of the biggest problems in joining the refractory metals lie in welding. Engineers would like to have:

- More ductile welds in molybdenum, tungsten and high strength columbium alloys.
- High strength tantalum alloys that are weldable.

Molybdenum can be joined by shielded inert-gas arc welding but welds are not ductile at room temperature and are notch sensitive. Ductility is lowered by recrystallization in fusion and heat affected zones (brazing produces a similar effect).

Minute quantities of oxygen, nitrogen and carbon can contribute to embrittlement; however, their effect can be minimized by using ultra-high-purity molybdenum and welding in dry boxes in inert gas. Ductility is also improved by: heat treating after welding, cold working welds, raising welding speeds, and stressing welds at elevated temperatures.

Despite these treatments it is still difficult to obtain ductility in molybdenum fusion welds. Current work is directed toward: 1) using a molybdenum–50% rhenium alloy weld metal to lower ductile-to-brittle transition temperature of the weld bead; and 2) using electron beam welding to reduce weld contamination and width of the heat affected zone. Varying success has also been reported with ultrasonic welding but because of the problem of transferring energy to the interface it will certainly be limited to thin sheet.

Tungsten can be welded by inert-gas shielded arc much like molybdenum. Electron beam welding can also be used. Although sound welds can be made they are brittle at room temperature. Unfortunately, ductile welds are difficult to make because the transition temperature of welded joints is not appreciably higher than that of the base metal.

Columbium can be embrittled by nitrogen and oxygen during welding but has greater tolerance for these elements than molybdenum. Tungsten arc welds with good ductility can be produced in unalloyed columbium provided that atmospheric contamination is avoided.

Development of weldable alloys will have to account for the effects of alloying elements on ductility. Tungsten, molybdenum and chromium can cause a rapid rise in transition temperature. However, fairly large amounts of vanadium, tantalum, titanium, hafnium and zirconium can be added without raising transition temperature.

Tantalum has much the same welding characteristics as columbium. It is being welded by shielded inert-gas arc, resistance and electron beam methods. Welds in pure tantalum have excellent ductility, but little is known about the weldability of future alloys.

NEW DEVELOPMENTS IN ABLATION MATERIALS

Since the discovery of man-made ablative materials only a decade ago there has been rapid progress in developing new and improved materials such as those shown in the table.

PRESENT ABLATIVE MATERIALS

Homogeneous Ablators	Composite Ablators
Plastics	Reinforced plastics
TFE fluorocarbon	Reinforced ceramics
Polyethylene	Ceramic-filled metal honeycomb
Polyamides	Metal-fiber-reinforced ceramic
Phenolics	Impregnated systems
Modified epoxies	Organic-filled porous ceramic
Foamed resins	Inorganic-particle-filled refractory
Carbonized resins	
Ceramics	
Fused silica	
Zirconia	
Magnesia	
Foamed ceramics	

Organic and inorganic polymers with high endothermic capacity are being made by modifying existing polymers, by copolymerization, and by synthesizing new polymers. Two new materials recently developed are a castor-oil-modified epoxy and a phenolic resin incorporating elastomeric polymer. Others under development are: high carbon aromatics, metalloxanes, triazines, polyazaporphyrins, organometallic chelates and borazoles.

Ceramics are receiving much attention now that their tendency to break can be overcome by reinforcement. Pure and mixed oxides of zirconia, thoria, magnesia and hafnia are now being used as bulk ablators or coatings.

Composite materials are used in a unique rocket nozzle which has withstood 6800 F. It consists of: 1) an internal tungsten coating to delay heat transfer; 2) an insulative layer of porous zirconia foam reinforced with stainless steel honeycomb; and 3) a load-bearing member of silica-fiber-reinforced plastic adhesive bonded to reinforced ceramic.

Reinforcements are becoming more important for adding strength. Good results are being obtained with fibers of silica, zirconia, graphite and tungsten. Refractory metal wires, meshes and honeycombs are improving the ablative properties of ceramics. Also promising is the "in situ" synthesis of a refractory material on the ablator surface.

Dimensionally stable materials are being developed by: 1) orienting reinforcing fibers perpendicular to the surface; 2) using intumescent ablators such as modified epoxies which swell and char when heated and make up for material lost at the surface; and 3) generating gases which help maintain dimensions by continuously cooling the surface.

EXPANDABLE STRUCTURES 'RIGIDIZED' IN SPACE

Lightweight expandable structures that are rigidized in space look quite promising for future manned and unmanned space vehicles. Current development centers around a flexible structure consisting of three layers: an outer fabric layer with an external elastomer coating; a middle layer of fiberglass cloth or similar reinforcing fabric impregnated with a viscous prepolymer; and an inner layer of a lightweight barrier to prevent "self-adhesion" of the uninflated structure during storage.

The structure is formed by releasing a gas which, in addition to inflating the structure, contains a reactant (such as amines and water vapor) that converts the liquid prepolymer in the inner layer to a rigid reinforced structure capable of withstanding the light pressures of rarified atmospheres. Development on the structures is well along and improvements are now being made to widen their usable temperature range and to lower their weight.

References

The preceding summaries are based on the papers listed below. All were presented at the Materials Symposium held by the Air Force's Aeronautical Systems Div. in Phoenix, Ariz., Sept '61. Note that for reference purposes the papers are listed in the same order as their respective summaries above. The complete papers, as well as all others presented at the Symposium, are now available in ASD Technical Report 61-322, entitled "Materials Symposium."

"Ceramics and Intermetallics," by I. D. Latva.

"Soft Magnetic Metallic Materials," by John C. Olson.

"Coatings for Temperature Control in Space Vehicles," by J. H. Weaver and Lt. Cecil Jacobs.

"Refractory Metals as Engineering Materials," by T. D. Cooper.

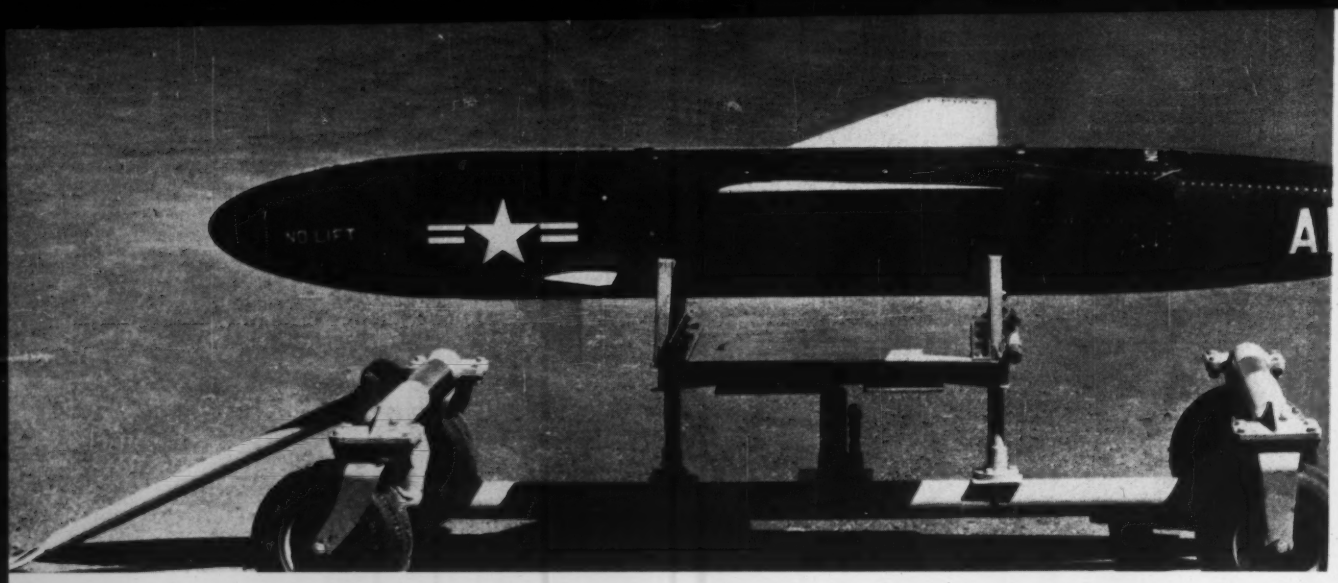
"Welding and Brazing Space Age Metals," by R. Bowman.

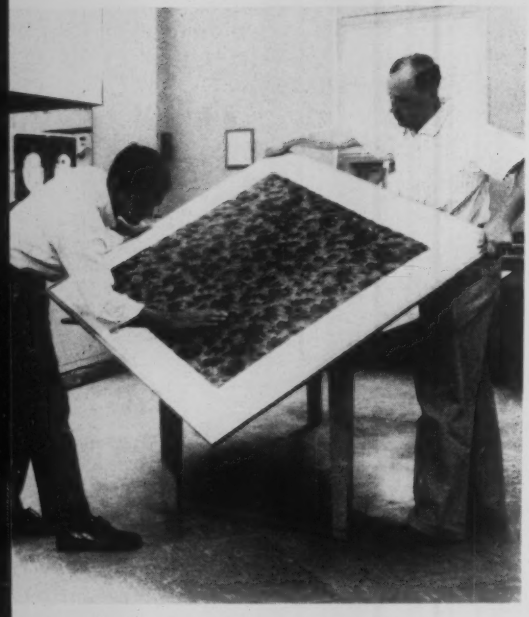
"Ablative Materials," by Donald L. Schmidt.

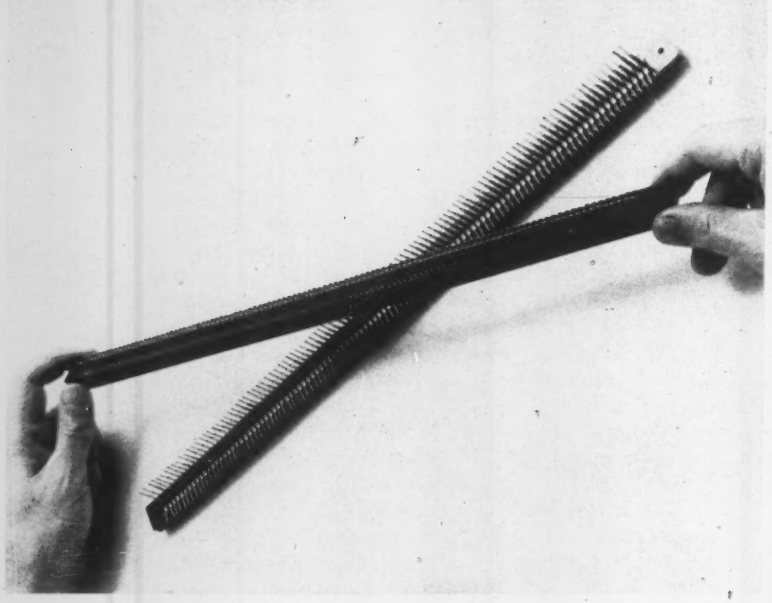
"Elastomers," by Dr. W. E. Gibbs, W. R. Griffin, and R. G. Spain.

***Materials problems** are intensified in rocket booster with million-pound thrust being tested here.*

'Rocketdyne Div., North American Aviation, Inc.







Fuselage sections
(both nose and aft) for this rocket-powered RP-76 target drone were fabricated of DAP prepregs to provide high strength-to-weight ratio combined with heat resistance and excellent electrical properties.

Fabric laminate
provides surface resistant to abrasion, scratching, heat, chemicals and moisture.

Printed circuit connector
17 in. long molded of DAIP holds multitude of connectors firmly yet maintains excellent electrical properties at high humidities up to 400-450 F.

Fin tip housing
(arrow) on Cessna 310 is molded from DAP prepreg supplied by Cordo Chemical Corp. Resistance to weathering and erosion, as well as good finish, are required.

Transparent overlay
for 14-ft conference table protects and enhances natural walnut grain. Cherry panels in background are also surfaced with DAP overlay.

New resins, new forms now in . . .

Allylic Plastics

by J. L. Shafer, *Dapon Dept., Food Machinery and Chemical Corp.*

From specialty materials for electrical components, allylic plastics have grown to a diverse family of premium plastics. The original DAP (diallyl phthalate) resins have been joined by DAIP (diallyl isophthalate) resins . . . the original molding compounds have been joined by laminating resins, coatings and decorative overlays.

Today, allylics are being used in many critical applications . . . ■ Close tolerance, precision molded wrist watch parts where dimensional stability is vital ■ Molded auto parts that need resistance to moisture, corrosion and weathering ■ Molded insulators, potentiometers and circuit boards where electrical insulating characteristics and dimensional stability are needed ■ Decorative overlay and surfacing laminates that provide hard, abrasion resistant, yet attractive surfaces for home, office and institutional furniture ■ Low pressure laminated tubing, ducting, and missile parts where resistance to heat and chemicals, combined with excellent electrical insulating properties, is essential.

These are only a few of the many applications where the relatively high cost of allylics (glass-reinforced DAP molding compounds, for example, may cost anywhere from $.90 to $1.80 per lb) has been more than offset by improved performance. This, of course, does not happen in all applications, and their premium price makes allylics impractical for many uses. But for molded or laminated plastics parts where requirements call for resistance to heat, humidity, chemicals, weathering and wear, or for electrical insulating properties such as exceedingly low loss and high insulation resistance; or for precise molded dimension and exceptional dimensional stability, it may well pay you to take another look at allylics.

Differ from polyesters

Although allylics have been classified by many as polyester resins, they are clearly distinguishable from polyesters on the basis of chemical structure. And the distinction in chemical structure provides a substantial distinction in performance of

the cured polymers. Thus allylics warrant separate classification.

The structural difference lies in the location of the ester linkages in the two polymers. Allylic polymers are made up of hydrocarbon backbones with attached or *pendant* unsaturated ester groups; in polyesters, the ester linkages exist in the *backbone* of the polymer. The absence of ester linkages along the backbone of the allylic molecule contributes to its characteristic electrical and hydrolytic stability.

Most allylic plastics are based on DAP or DAIP prepolymers or partial polymers. They are sold to formulators as dry, free-flowing powders (e.g., Dapon and Dapon M, our company's DAP and DAIP prepolymers, respectively). Formulators then mix the prepolymer with suitable fillers, and/or reinforcements and catalysts to form molding compounds, or dissolve the resin in proper solvents to form varnishes, or formulate a suitable resin solution for impregnating paper or glass reinforcements to provide either decorative laminates or prepreg materials for reinforced plastics molding.

TABLE 1—COMPARATIVE PROPERTIES OF TYPICAL GLASS-FILLED MOLDING COMPOUNDS

Compound →	DAP	Melamine	Phenolic	Silicone
PHYSICAL PROPERTIES				
Specific Gravity	1.55-1.68	1.9-2.0	1.75-1.95	1.68-2.0
Specific Volume, cu in./lb	17.8-17.3	14.4-13.8	15.8-14.1	16.5-13.8
Coef of Ther Exp, 10^{-5} per °F	9	0.83	0.88	0.44
Water Abs (24 hr, ⅛ in.), %	0.12-0.35	0.3-0.6	0.1-1.2	0.1-0.2
Heat Res (cont), F	400-450	300-400	350-450	>600
Heat Dist Temp (264 psi), F	325-500	400	>600	>900
Burning Rate	Self-ext	None	None	None to slow
MECHANICAL PROPERTIES				
Ten Str, 1000 psi	6.5-7	6-10	5-10	4-5
Elong, %	—	—	0.2	—
Mod of Elast in Ten, 10^5 psi	15-20	—	33	—
Compr Str, 1000 psi	25-29	26-32	17-26	10-15
Flex Str, 1000 psi	9.5-18	15-23	10-60	10-14
Izod Impact Str, ft-lb/in. notch[a]	0.5-15.0	8.0-16.0	10-50	3-15
Rockwell Hardness	M108-110	—	M95-100	M84
ELECTRICAL PROPERTIES				
Vol Res, ohm-cm[b]	1×10^5 to 3×10^{11}	7×10^{11}	7×10^{12}	10^{10}-10^{14}
Dielec Str (⅛-in.), v/mil				
Short Time	350-400	250-300	140-370	200-400
Step-by-Step	300-450	140	120-270	125-300
Dielec Const				
60 Cps	4.3	—	7.1	3.3-5.2
10^3 Cps	4.1-4.5	—	6.9	3.2-5.0
10^6 Cps	3.8-4.5	—	4.6-6.6	3.2-4.7
Dissip Factor				
60 Cps	0.01	—	0.05	0.004-0.03
10^3 Cps	0.004-0.008	—	0.02	0.0035-0.02
10^6 Cps	0.009-0.018	—	0.02	0.002-0.02
Arc Res, sec	105-125	180	4-150	150-250
Insulation Resistance, megohms				
As molded[c]	5×10^6	1×10^6 [d]	1×10^6 [e]	2×10^6 [f]
After 30 Days, 100% RH[a]	3×10^6	15	100	100
After 30 Days, 100% RH[b]	5×10^6	90	100	100
Effect of Sunlight	None	Slight	Darkening	None to slight
Effect of Acids				
Weak	None	None	None to sl	None to sl
Strong	Slight	Decomposes	Decomp by some	Slight
Effect of Alkalis				
Weak	None	None	Sl to marked	None to sl
Strong	Slight	None to sl	Marked [i]	Sl to marked
Effect of Organic Solvents	None	None	None on bleed-proof materials	Attacked by some
MOLDING CHARACTERISTICS				
Moldability	Excellent	Good	Good	Good
Compression Molding				
Temperature, F	270-320	280-340	280-350	310-360
Pressure, psi	500-2000	3000-6000	1000-5000	1000-5000
Compression Ratio	1.9-4.8	—	6.1	6-9
Mold Shrinkage, in./in.	0-0.005	0.001-0.003	0.0001-0.001	0-0.005

[a] ½ by ½-in. specimen. [b] 50% RH, 73 F.
[c] Conditioned 2 days at RT in desiccator; all insulation resistance data courtesy Mesa Plastics.
[d] Mineral-filled melamine (type MME). [e] Mineral-filled electrical grade phenolic (type MFE).
[f] Mineral-filled silicone (type MSG). [g] Before removal of moisture film.
[h] After removal of moisture film. [i] Unless alkali resistant resin used.

Variety of molding compounds

Table 1 compares properties of a glass-filled DAP compound with those of several other glass-reinforced thermosetting molding compounds. In addition to glass, compounds are available reinforced with asbestos, polyester and acrylic fibers, as well as mineral-filled. Among military specifications they meet are MIL-M-18794, Type SDI-5, SDI-30 and SDG materials; MIL-M-14, Type MDG; and MIL-M-19833, Type GDI-30 materials. Additional property data on types other than glass-reinforced are given in M/DE's *Materials Selector Issue*, Mid-Oct '61, p 193.

The outstanding properties of these compounds are their high insulation resistance and dimensional stability. Also, dielectric properties as well as physical properties are retained exceptionally well after exposure to moisture and elevated temperatures. The major difference between compounds made from the two prepolymers, DAP and DAIP, is in heat resistance. DAP compounds have maximum continuous service temperatures of about 300-350 F; those of DAIP are in the 350-450 F range. Both materials have good chemical stability on exposure to acids, alkalis and solvents.

The compounds have good flow characteristics, and low mold and

negligible post-mold shrinkage, permitting economical molding of intricate parts with multiple delicate inserts. Cycle times can be as short as 15 sec. Hot strength and mold release are excellent.

Reinforced plastics use grows

Although limited in the past, use of allylic resins in reinforced plastics parts is growing, primarily in applications requiring excellent and stable electrical properties, along with dimensional stability and good resistance to heat and chemicals. Such uses include aircraft and missile parts, junction boxes, radomes, ducting and tubing.

Most such parts are made from prepreg materials (reinforcing cloths, mats or woven rovings, impregnated with resin and partially cured), because liquid allylic systems contain solvents that make high quality laminates difficult to produce by wet lay-up techniques. Prepregs, when molded by contact, vacuum or pressure bag, or matched metal molding techniques, cure by addition polymerization. Thus no gases or liquids are evolved, facilitating production of void-free laminates. Typical properties of reinforced allylic laminates are shown in Table 2.

Decorative laminates are new

Allylic decorative and transparent overlay laminates for surfacing of wood and other materials have only been available for about a year. Overlays are usually in the form of a DAP-impregnated paper —either printed or translucently clear (when pressed) — which is applied to the substrate and cured. The resulting surface is hard and insoluble; it resists moisture, alcohol, heat, cold and abrasion. Table 3 compares qualitatively a DAP decorative laminate with other decorative laminating materials.

The major benefit offered by allylics for such use is the relatively low pressures (about 100-200 psi) required to laminate. Thus, allylic laminates can be produced directly on "soft" core stocks and veneers without crushing or shearing the substrate. During lamination, the allylic resin softens and impregnates the substrate, forming a diffusion bond.

This technique has obvious benefits over conventional methods of forming such materials as melamine-surfaced laminates, wherein a thin, hard melamine laminate is formed at pressures of about 800-1000 psi and is then bonded at lower pressures to the core stock.

DAP laminates can often be made on existing presses in woodworking and furniture plants, providing substantial economies. It is difficult to state general cost figures meaningfully, but in large quantities, decorative DAP sheets and overlays cost about 11¢ and 0.65¢ per sq ft, respectively. Laminating costs are usually about 0.26¢ per sq ft.

Allylic monomers important

Allylic monomers when used as crosslinking agents for polyester or alkyd resins can substantially alter both processing and performance characteristics of the finished resin. Thus, although such formulating is usually left to the processor, a brief summary of the effects of allylic monomers in resin formulations is warranted.

From the performance standpoint, DAP and DAIP monomers may provide polyesters or alkyds with improved strength, rigidity, heat resistance, electrical properties, and weatherability, as well as reduced shrinkage. Polyesters formulated with such monomers are higher in cost because the allylic monomer is higher in cost than the styrene or vinyl toluene monomer it replaces.

From the processing standpoint, allylic monomers provide polyesters with greater uniformity of molding quality (because they shrink less than vinyl toluene, styrene or methyl methacrylate monomers). They also provide lower exotherm, lower volatility, improved storage stability and shelf life, and improved wet-out of glass fibers. DAP monomer is also used as a nonvolatile catalyst carrier for spray molding of styrene-type polyesters.

New allylic monomers — Newly developed allylic monomers look particularly promising for structural polyester laminates. Such new monomers as diallyl maleate and diallyl adipate are reported to provide polyesters with improved heat resistance. Diallyl chlorendate is reported to improve both heat resistance and flame resistance when used as a crosslinking monomer with polyesters, and also when combined with DAP and DAIP prepolymers in order to produce allylic plastics.

TABLE 2—TYPICAL PROPERTIES OF DAP LAMINATES (Fabricated from Prepreg)

MECHANICAL PROPERTIES[a]	
Flexural Strength, 1000 psi	
As rec'd	76
At 200 F	61
At 300 F	45
At 400 F	19.5
Flex Mod of Elast, 10^6 psi	
As Rec'd	2.88
At 200 F	2.58
At 300 F	2.21
At 400 F	1.40
Tensile Strength, 1000 psi	
As Rec'd	47
At 200 F	40.5
At 300 F	40.7
At 400 F	21
Ten Mod of Elast, 10^6 psi	
As Rec'd	2.71
At 200 F	2.90
At 300 F	2.64
At 400 F	1.88
ELECTRICAL PROPERTIES[b] (At Radar Frequency, 8500-10,000 Mc)	
Dielectric Constant	
Dry	4.24
Wet	4.26
Loss Tangent	
Dry	0.0085
Wet	0.009

[a] ⅛ in., 12 ply laminates of 181 volan A glass cloth, 37.7% resin, pressed at 280 F for 30 min and 100 psi pressure. Specimens tested at temperature after 30 min exposure.
[b] Typical values for commercially available Dapon 35 prepreg.

TABLE 3—COMPARISON OF TYPICAL DECORATIVE PLASTIC LAMINATES

Type →	DAP	Melamine-Phenolic	Polyester	
			Sheet	Film
Chem Res.	Exc	Exc	Good	Good[a]
Ht Res.	Exc	Exc	Good	Poor[b]
Abrasion				
Wet	Exc	Good	Good	Exc
Dry	Exc	Exc	Fair	Exc

[a] Organic solvent resistance poor.
[b] Thermoplastic.

Adding antimony helps

Solders for 250 F Service

by W. P. McQuillan,
Materials Laboratories, Westinghouse Electric Corp.

■ Commercially pure tin has been used in the electrical industry for many years to solder coil leads to commutator risers and banding wire on large d.c. machines. An expected increase in operating temperatures of these machines from 175 F to approximately 250 F requires use of a solder with better elevated temperature mechanical properties than those available in pure tin.

Tin-antimony solders have been used for electrical applications in Europe for many years. These alloys, although used in this country for some mechanical applications, have not generally been used in electrical connections.

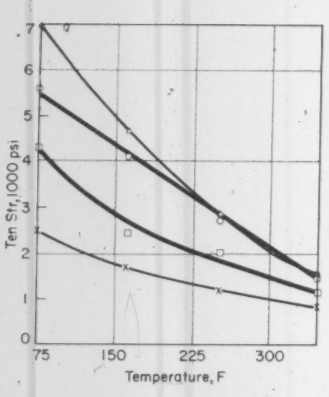
Tests made both on bulk samples and soldered joints (see graphs) have established that properties of tin-antimony solders are superior to those of commercially pure tin. Both 93% tin–7% antimony and 95% tin–5% antimony solders performed satisfactorily. The latter alloy is more commonly used commercially.

Two words of caution

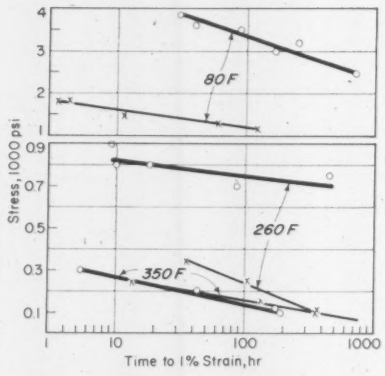
1. Pure tin and tin-antimony solders should not be used to join copper components when operating temperature will exceed 250 F. As copper diffuses into the solder, brittle copper-tin compounds are formed. The joint becomes brittle and may fail easily in impact loading.

2. Solders containing antimony cannot be used to join zinc-coated materials. The antimony-zinc compounds that form are reported to be very brittle.

Testing Bulk Specimens

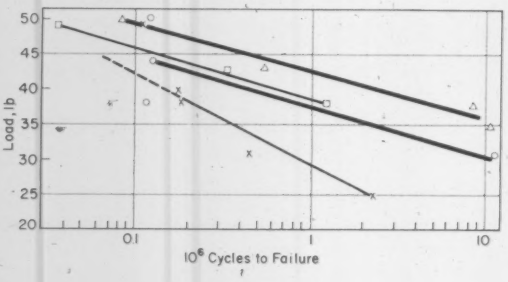


***Tensile strength** of tin increases by 600 psi per 1% added antimony. Differences, significant at room temperature and 260 F, are minimized at 350 F (100° F below melting point).*

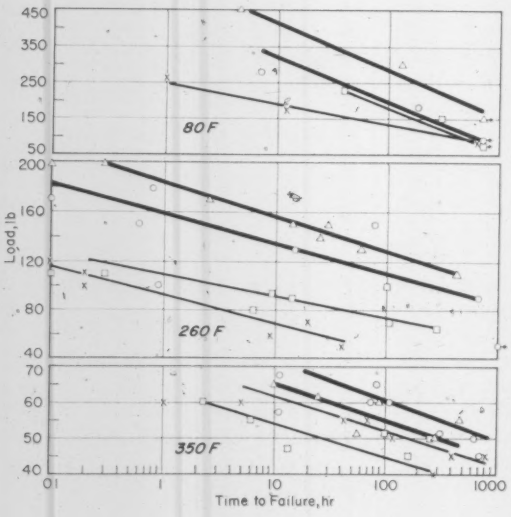


***Creep strength** of pure tin almost equals that of tin-antimony alloys at 350 F.*

Testing Double-shear Wire Joints



***Fatigue strength** at 350 F is increased by alloying tin solder with antimony.*



***Creep strength** is higher at all temperatures for joints soldered with tin-antimony than for joints soldered with pure tin.*

KEY	Sn	Sb
△	93	7
○	95	5
□	97	3
x	100	0

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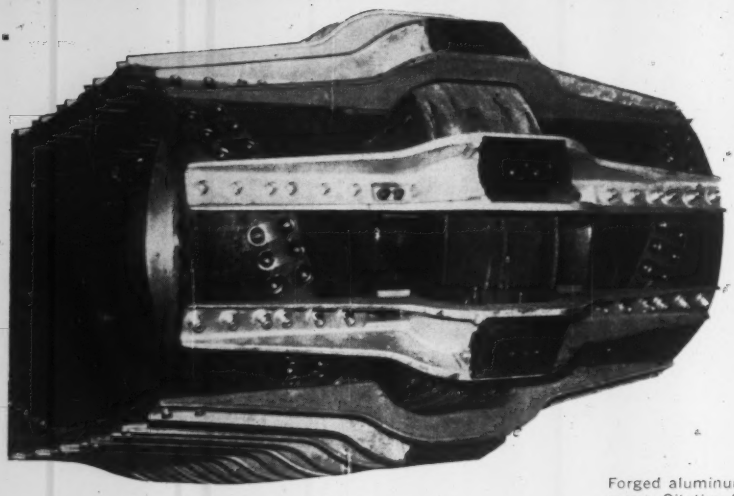
Win one of the 16 CASH AWARDS for Best Use of Engineering Materials

To encourage sound, imaginative and progressive application of engineering materials, MATERIALS IN DESIGN ENGINEERING this year sponsors its sixth annual Awards Competition for Best Use of Engineering Materials. As in previous years your entry will be reviewed by a distinguished board of judges. There will be 16 cash awards, each accompanied by an appropriate plaque.

Award-winning entries will be published in the April 1962 Design Engineering Show issue of MATERIALS IN DESIGN ENGINEERING. Some nonwinning entries will also be published in subsequent issues and paid for at the usual rate.

LAST YEAR . . . . . .



Forged aluminum track bar won a Citation for C. J. Nuttall, Jr., and the Engineering Group at Wilson, Nuttall, Raimond Engineers, Inc.

this year's

board of judges

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Chief Production Engineer
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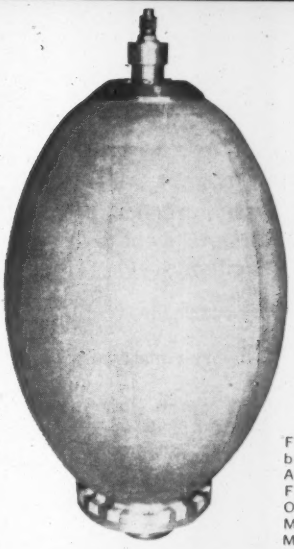
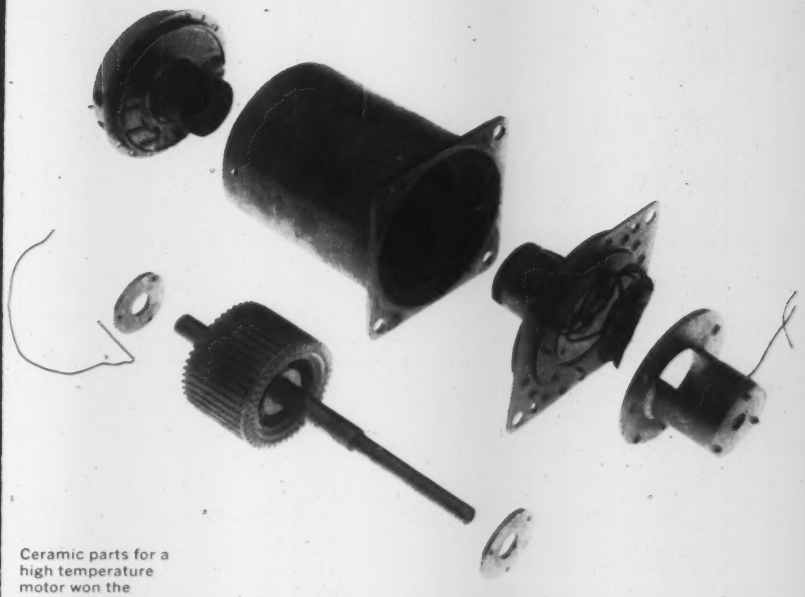


Fluorosilicone fuel bladder won an Award of Merit for F. E. Clark, O. Markles and M. Clancy of the Material and Process Section, North American Aviation, Inc.



Ceramic parts for a high temperature motor won the First Award for R. H. Schmitt at AiResearch Mfg. Co., Div. of The Garrett Corp.

it's easy for you to enter... simply follow these steps

1. **Select your best work of 1961.** You can enter any part or product which you worked on, provided that: (1) you are employed in the product manufacturing industries, and (2) the design was completed during 1961 or the product went into production during 1961. An entry may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, etc.). The product may be a complete assembly, a subassembly, a single part or a component.

2. **Prepare your entry—it's easy.** You need not write up your entry in the form of an article. Entries will not be judged for literary quality. See back page of this folder for details on the information that must be submitted with each entry.

3. **Send in your entry by January 15.** Entries must be mailed no later than January 15, 1962. Mail all entries to Awards Editor, MATERIALS IN DESIGN ENGINEERING, 430 Park Ave., New York 22, N. Y.

The photos above show three of last year's winning entries. The other 13 winners were:

P. A. Lee, Planet Products Corp.

P. Hines, New England Instrument Co.

J. Koziarski, Denver Div., and P. Dick, Nuclear Div., The Martin Co.

M. H. Riesgraf, Aeronautical Div., Minneapolis-Honeywell Regulator Co.

Employee Activities Committee, The Barden Corp.

C. Schroeder, Boeing Aircraft Co.

G. L. Branch and R. Y. Scapple, Materials and Processes Section, Hughes Aircraft Co.

G. E. Sutila and J. F. Goodwin, Aerophysics Laboratory, Douglas Aircraft Co., Inc.

T. F. Bellinger and L. A. Burton, Allis-Chalmers Mfg. Co.

D. R. Kerstetter, Materials Engineering Dept., Electronic Tube Div., Sylvania Products Inc.

R. F. Howard, Materials and Processes Group, Bell Helicopter Co.

E. H. Anderson and C. F. Heidorn, Anderson Controls Inc.

H. F. Everett, The Foregger Co., Inc.

ENTRY FORM

Materials in Design Engineering
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6th Annual Awards Competition
for the Best Use of Engineering Materials

Eligibility

Any person(s), department, group, or organization in the product manufacturing industries may submit an entry or entries. No one employed by a materials producer or supplier is eligible.

Preparation of Entries

1. The following information must be provided with each entry in order to allow the judges to make competent decisions:

a. A detailed description of the product, including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.

b. A description of requirements in service and/or fabrication that must be met by the product and the material.

c. A description of the previously used materials (if entry is a redesign).

d. A description of the material or materials selected for the product entry.

e. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice. **Back them up with evidence—facts, data, charts, tables on performance, quality or cost.**

In general, entries should show that the materials selected for the product—

- Resulted in improved performance
- and/or lower costs
- or Best met the design and service requirements.

Remember! The more detailed and documented your entry, the more consideration it will receive from the judges.

2. Entries or portions of entries and samples will not be returned unless requested. Entries should not include valuable papers or other material which must be returned, because there is always some danger of loss or mutilation. Whenever possible, photostats, photographs, or other copies of such materials should be used instead.

3. All entries must be postmarked not later than January 15, 1962. The judges reserve the right to withhold awards at their discretion.

Publication of Entries

MATERIALS IN DESIGN ENGINEERING plans to publish articles on the winning entries and reserves the right to publish articles based on entries not winning awards.

Here are a few ways in which a product can benefit from intelligent materials selection:

Long service life

Lower basic materials cost

Less material required

Improved appearance

Permitted a new design

Reduced production costs

Improved service performance

Reduced scrap

Reduced or eliminated maintenance

Permitted lower cost design

Allowed greater design flexibility

Simplified production and fabrication

entry form

Mail to: Awards Editor, MATERIALS IN DESIGN ENGINEERING, 430 Park Ave., New York 22, N. Y.

Name _____ Title _____

Name(s) of person(s), group or company who would receive award _____

_____

Company _____

Street address _____ City _____ State _____

Name or brief description of product being entered _____

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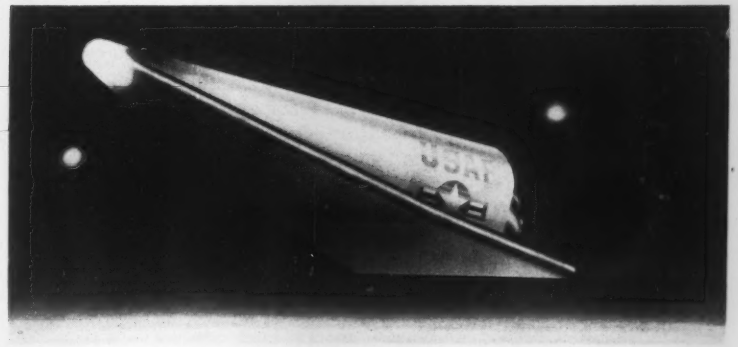
Was design (or redesign) of entry either completed or placed in production during 1961? _____

Does your employer consent to entry under terms of this competition? _____

NOTE: Please observe the rules given above. Use a separate blank for each entry; additional entry blanks available on request. Attach entry blank, or its equivalent, to your entry.



ASSET re-entry vehicle, being developed by McDonnell Aircraft under auspices of USAF's Aeronautical Systems Div., will use columbium leading edge.

Columbium

a bright future, but how soon?

by Donald Peckner, *Associate Editor, Materials in Design Engineering*

There is no question but that columbium, the subject of this status report, will be an important engineering metal of the future. But, though everyone working in the field agrees that columbium and columbium-base alloys have a bright future, few will guess just how soon this future will arrive. Companies that have made—or plan to make—substantial investments in alloy development and production facilities cannot say today at what point they expect to recover their investment and begin making a profit.

One fact stands out: there are no current large scale civilian applications to help increase the volume of metal used. Practically all applications are geared to government requirements, a factor that contributes to the generally blurry picture of columbium. For example, the ANP (aircraft nuclear propulsion) program, recently cancelled, used up to 90% of the columbium sold in 1960. If the re-entry vehicle programs, notably Dyna-Soar and ASSET had not taken up the slack there literally would be no current major market for columbium and its alloys.

Why, then, are companies entering the field when there appears to be so little hope for profits in the really near future? Dr. D. T. Hurd, manager of research, Lamp Metals Components Dept., General Electric Co., probably comes close to the mark when he says, "Management is being convinced that expenditures in this field are essential, not because of the dollar value of the refractory metal business per se but because of the dollar value of the products using the refractory metals. We want to make certain that the performance of a few million dollars worth of refractory metals does not, in any way, jeopardize the performance of tens of millions of dollars worth of space systems and nuclear reactors."

The next nine pages will give you a concise summary of where columbium will be applied—and why, which alloys will be important in the future, and what problems you may encounter if you have to fabricate columbium-base alloys.

Special Report No. **190,** *December, 1961*

The overall picture: a thumbnail roundup

Eight basic properties of columbium make it attractive as an alloying base material. These are:

1. Low thermal-neutron-capture cross section (1.1 barns).
2. High melting point (4379 F) and good potential for retention of strength at temperatures above the maximum service temperature of the superalloys in common use.
3. Excellent ductility down to low temperatures (–320 F) combined with fabricability.
4. High transition temperature for superconductivity (8.2 K).
5. Refractoriness of its oxide, especially when compared with molybdenum.
6. Low density (0.31 lb per cu in.) compared with other refractory metals. Density, in fact, is comparable to that of iron (0.28) and nickel (0.32).
7. General chemical inactivity at room temperature.
8. Relatively high coefficient of thermal conductivity, an important aid to the coating problem.

Table 1 compares the physical properties of four significant refractory metals.

Many uses on drawing boards

The eight "plus factors" above make columbium and its alloys attractive metals to consider for many applications, not all of which require high temperature strength.

Three principal uses—Space vehicles, nuclear reactors and superconductors are the three principal areas in which the use of columbium is being considered.

Dyna-Soar and ASSET, glide reentry vehicles, are the space projects giving the most active consideration to the use of columbium alloys right now. Principal use would be in leading edge applications where temperature will range up to 3000 F.

In other space projects, columbium alloys are being considered for tubing applications in the high temperature loops of various nuclear power reactor systems that will use liquid metal heat exchangers.

Superconducting devices maintain a magnetic field at cryogenic temperatures with only a small initial power input. (Benefits of superconductive devices were discussed in M/DE, July '61, p 107.) Impetus has been given to their development by the announcement that Wah Chang Corp. is producing the superconductors Cb-33Zr and Cb_3Sn in wire lengths up to 5000 ft.

Superconducting alloys can be divided into three groups for potential applications: filamentary (in which the superconductor is distributed in a continuous network through a non-superconducting metal matrix), bulk, and film superconductors:

1. Filamentary superconductors, as represented by Cb-33Zr and Cb_3Sn wires, have applications in d.c. fields. Principal use will be as magnet wire.
2. Bulk superconductors will be used in a.c. applications and where a pure superconducting phase is required. The cryogenic gyroscope is a possible application.
3. Film superconductors are being used now in lead-tin thin film cryotrons. If columbium and tantalum can be vapor deposited, they will be a more desirable couple. The low critical temperature of tin (3.2 K) creates temperature problems that could be resolved by using columbium (with a critical temperature of 8 K).

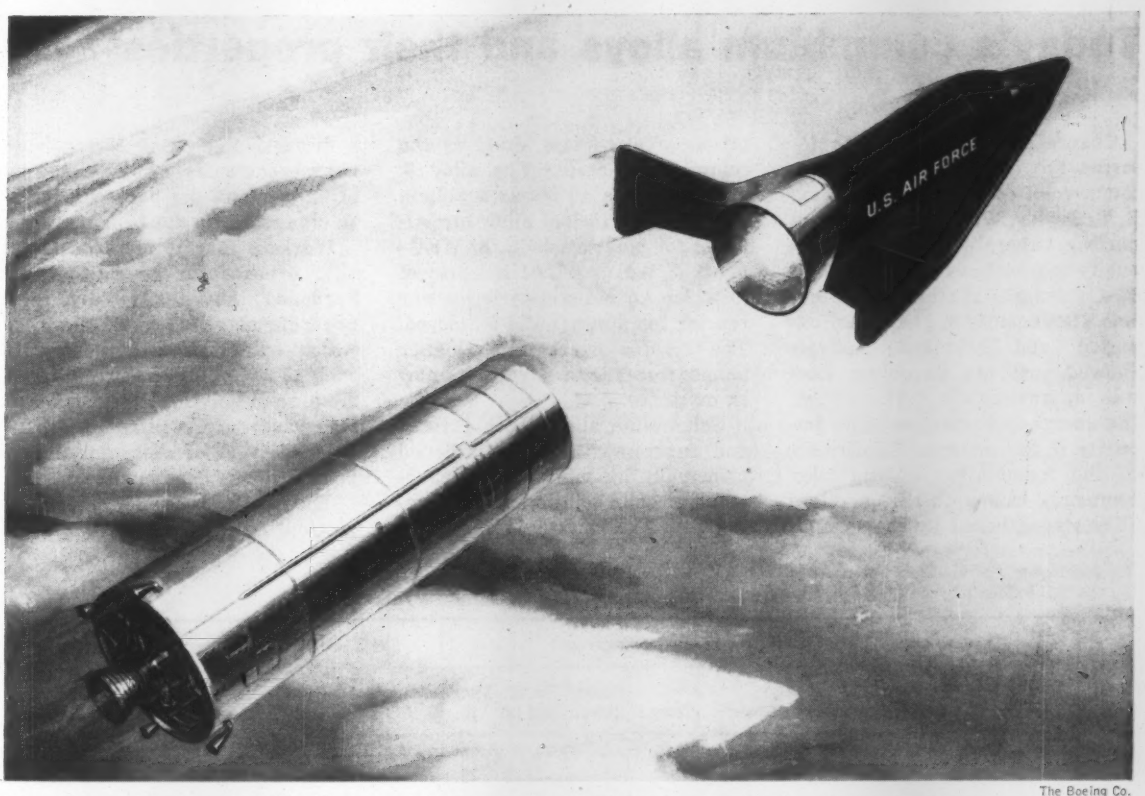
Other uses further off—Use of columbium in wet chemical corrosion applications will be relatively minor since columbium alloys, in this area, occupy an uncomfortable middle ground. At one end of the scale, columbium cannot compete with titanium, zirconium or stainless steel on a cost basis; at the other end, tantalum has better corrosion resistance. You can look for potential applications in central power stations, however, as operating temperatures approach 1400 to 1500 F. Here, corrosion resistance combined with creep strength will make columbium alloys logical candidates for blading materials.

Probably the greatest impetus to expanded use of columbium will come when suitable long-time coatings become available for service up to 2500 to 3000 F. The next generation of aircraft turbines—now limited to an 1800 F operating ceiling—will operate at temperatures well over 2000 F. Columbium alloys, with their favorable combination of density, strength and oxidation resistance, are the most likely candidates for the job. Better coatings, certainly, will make it easier to apply columbium alloys in land-based gas turbines operating up to 2500 F.

Columbium is also being investigated as a capacitor material but full application awaits the development of a good dielectric

TABLE 1—PHYSICAL PROPERTIES OF FOUR REFRACTORY METALS

Metal	Melt Pt, F	Boil Pt, F	Ther Cond, Btu/lb/°F	Ther Exp, 10^{-6} in./in./°F	Efec Res, μ ohm-cm	Thermal Neutron Cross Section, barns/atom	Density, lb/cu in.	Mod of Elast, 10^6 psi
Columbium	4475	8,900	28	4	13.1	1.1	0.31	15
Tungsten	6170	10,700	68	2.2	5.5	19.2	0.697	50
Tantalum	5440	9,800	32	3.6	13.5	21.3	0.6	27
Molybdenum	4730	10,040	77	3.0	5.2	2.4	0.369	46



The Boeing Co.

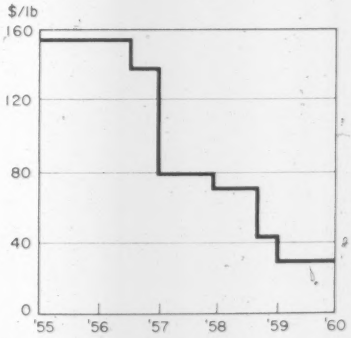
Dyna-Soar, *a hypersonic glide re-entry vehicle, may use columbium alloys for leading edge applications.*

oxide to make the material competitive with tantalum.

Price is not a factor

You don't have to have too extensive a research or development program on columbium to begin eating away at your budget at an alarming rate. Price of columbium powder ranges between $36 to $55 per lb; as the powder is consolidated into finished mill forms prices begin to reach up over $100 per lb. At these prices investigations must be well planned to keep costs from skyrocketing.

Yet, K. C. Li, Jr., chairman and chief executive of Wah Chang Corp., feels that price is not really an important factor in this period of exploration into the feasibility of producing columbium components. The high cost of reducing columbium metal from the ore is directly related to the volume of metal used. Fig 1 shows how the price of powder has dropped 80% since 1955, a drop that can be directly related to the increase in consumption from perhaps 5000 lb in 1955 to approximately 300,000 lb in 1960.



1 *Price of columbium powder has decreased 80% in five years.*

According to Li, even if the price were to drop to $5 per lb overnight, there would be no rush to buy the metal or its alloys and apply them widely. There is promise for the future, however. If applications are found that will radically increase the use of columbium (and the aviation gas turbine is one of these), then we can expect prices to drop as low as $5 per lb. Right now, for example, one company has a chemical process to produce columbium directly from its ore. If production levels of 1000 lb per day could be maintained, it feels that costs would be immediately reduced to $10 per lb. Other producers, also, can be expected to lower prices as their market increases.

The real problems, then, are the technical and not the economic ones.

Today's columbium alloys and their properties

Chance is the only word to describe the discovery of the first commercial columbium-base alloy. R. T. Begley, Westinghouse Astronuclear Laboratory, ordered high purity columbium from a supplier. The strength of the columbium was significantly higher than expected and chemical analysis showed that the zirconium level was approximately 0.6%. Thus, the unexpected presence of an impurity in the material led directly to the formulation of the alloy commonly called Cb-1Zr, a dilute alloy strengthened by the precipitation of zirconium oxide in the columbium matrix. The alloy is available from all major suppliers and is the principal alloy investigated for application in the AEC–Pratt & Whitney CANEL project in which an indirect-cycle nuclear reactor for aircraft was developed. The reactor operates at higher temperatures than any others now in existence.

Columbium alloys, both present and future, will be strengthened principally by precipitation hardening or solid solution strengthening (see M/DE, Oct '61, p 115 for a discussion of these strengthening mechanisms). Alloy developers often combine the two techniques to obtain maximum benefits.

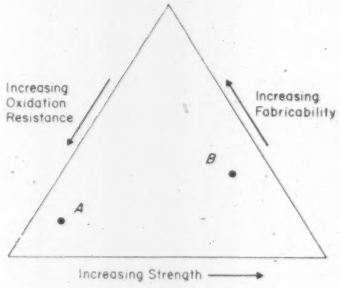
Workers in this field, incidentally, often refer to "dispersion hardened" alloys. Actually, they are referring to those alloys in which oxides of reactive metals such as zirconium are precipitated from solid solution. True dispersion hardening requires the separate addition of refractory compounds to the base metal.

The Cb-1Zr alloy is a "first generation" alloy. These are the al-

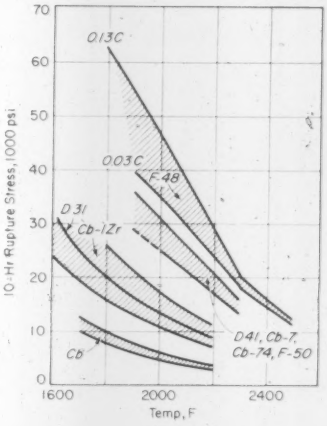
TABLE 2—FIRST GENERATION COLUMBIUM ALLOYS

Alloy	Composition, %								Tensile Properties				Stress—Rupture			Density, lb/cu in.	Recryst Temp, F	Developer
	Zr	Mo	W	Ta	Ti	V	Al	Condn	Temp, F	Yld Str, 1000 psi	Ten Str, 1000 psi	Elong, %	Temp, F	Time, hr	Stress, 1000 psi			
Cb-1Zr	0.75	—	—	—	—	—	—	—	70 2000 2200	— — —	47 23 19	36 23 17	2000	100 500	19 11	0.31	2200	Widely available
FS-82	0.75	—	—	33	—	—	—	—	70 2000 2400	— — —	55 30 13	— — 19	2000	10 100 500	25 18 14	0.368	2200	Fansteel
D31	—	10	—	—	10	—	—	Cold rolled[a]	70 2000 2400 2600	98 24.5 9.8 7	100 30 10.1 6.9	15 25 15 13	1800	230	15	0.292	2200	Du Pont
D41	—	6	20	—	10	—	—	Cold rolled	70 2000 2500[b]	— 53 —	125 56 25	10 26 35	2000	55	20	0.31	2550	Du Pont
F48[c]	1	5	15	—	—	—	—	Cold rolled	70 2000 2200	85 42 30	125 64 50	25 18 22	2000 2200	10 100 10 100	42 35 24 17	0.34	2800	General Electric
F50	1	5	15	—	5	—	—	Cold rolled	70 2000 2200	80 35 28	122 50 35	25 28 35	2000 2200	10 100 10 100	27 20 16 11	0.33	2500	General Electric
Cb-7	—	—	28	—	7	—	—	Cold rolled	2200 2500	41 24	48 28	18 53	2200	5.6 9	25 19.5	—	—	Union Carbide Metals
Cb-22	—	—	—	—	—	3	3	Cold rolled	2200	12.9	12.9	78	1830	50	15	0.28	—	Union Carbide Metals
Cb-65	0.8	—	—	—	7	—	—	Cold rolled[d]	70 2000	56 14	66 16	35 50	2000	10 100	10 6.3	—	2200	Union Carbide Metals
Cb-74[f]	5	—	10	—	—	—	—	Recryst[e]	70 2200	70 33	88 39	26 25	2200	2.3	25	0.32	2700	Union Carbide Metals

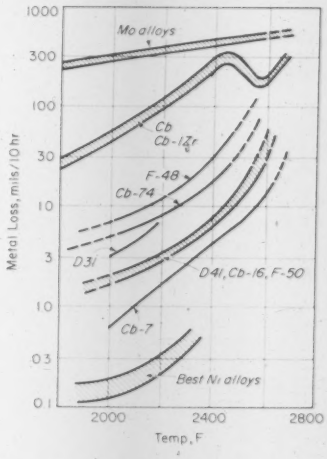
[a]Stress relieved 1 hr at 1750 F. [b]Tested in air. [c]Plus 0.05 O_2, 0.05 C. [d]Recryst 1 hr at 2200 F. [e]Recryst 1 hr at 2700 F.
[f]Now called Cb-752 by Haynes Stellite Co.
Sources: DMIC Rpt. 125 and proprietary literature.



2 *Three desirable features of columbium alloys cannot be combined to get the best of all three in one alloy. Alloy A has good oxidation resistance, relatively low strength and poor fabricability. Alloy B has high strength and moderate fabricability but oxidation resistance is poor.* (Adapted from Hugh Hix, Du Pont.)



3 *First generation columbium alloys compared on the basis of 10-hr stress-rupture strength in vacuum.* (Adapted from Jahnke.)



4 *First generation columbium alloys compare well with molybdenum alloys, but poorly when measured against the best nickel alloys.* (Adapted from Jahnke.)

loys arrived at during the first wave of columbium alloy development that began five years ago. The alloys are listed in Table 2.

The problems facing columbium alloy developers are summarized by the accompanying diagram (Fig 2). Oxidation resistance, strength and fabricability are all desirable assets in any high temperature alloy. But, as you can see, any effort to develop all three attributes in one alloy appears doomed to failure. Moving in the direction of any one characteristic reduces the relative contribution of at least one of the others. An oxidation resistant alloy might be found—but it would not be fabricable and would, therefore, remain a laboratory curiosity. Other examples of such exclusiveness can just as easily be drawn from the diagram.

The first generation alloys were developed by men who hoped to combine many of the favorable factors in one alloy. The goal was to develop a high strength, oxidation resistant alloy that could be easily fabricated but, as Fig 2 would lead you to expect, all such attempts failed.

The shotgun approach

For example, the highest strength alloy presently available, F-48, cannot be welded to produce a ductile joint unless it is heat treated in vacuum at 2500 F for 2 hr after welding. The vacuum requirements are so stringent ($>10^{-5}$ mm Hg) that this requirement is difficult to meet in the laboratory. Applied to full scale production assemblies, it is next to an impossible one. In addition, because strengthening is so strongly tied to the effects of the interstitial elements oxygen and carbon, the alloy must be held within tight specification limits for these elements. Fabricability and oxidation resistance of the end product leave much to be desired.

Some alloys, such as Cb-1Zr, FS-82 and Cb-752 (formerly called Cb-74), are easily fabricated and have good weld ductility. However, except for Cb-752, their strength is low compared with that of F-48 (see Table 2).

The first generation alloys can be grouped into four categories based on primary attributes:

- Strength: **F-48, Cb-752.**
- Strength plus moderate oxidation resistance: F-50, Cb-7, Cb-16, **D 31, D 41.**
- Ductility plus moderate oxidation resistance: Cb-65, **FS-82.**
- Ductility plus moderate strength: **Cb-1Zr.**

In our discussion of "second generation" alloys later on you will see that of these compositions only those in bold face are of great interest to their developers at this time.

First generation properties

The most important first generation alloys are these: Cb-1Zr, FS-82, F-48, D 31, and Cb-752. Their mechanical and physical properties are of interest because they can be considered the springboard from which future alloy generations will be developed.

Of the 12 first generation alloys, only these five seem to have survived the shakedown period. The other alloys will remain on the books but their future use will probably be minor.

Cb-1Zr was extensively investigated by Pratt & Whitney for application in the CANEL project. Their experience indicated that cold reductions of up to 50 to 60%

could be tolerated in tube drawing and up to 90% in sheet rolling, with no intermediate annealing. Based on 10-hr rupture strength values (Fig 3), load-carrying ability of Cb-1Zr, though significantly higher than that of pure columbium, is significantly lower than that of other columbium alloys with the exception of D 31. Rupture strength is a more significant measure than short-time tensile strength of a material's ability to carry loads at elevated temperatures.

Using zirconium as an alloying addition does not greatly improve the oxidation resistance of columbium (see Fig 4), but the weldability of the Cb-1Zr alloy goes a long way to make up for this shortcoming.

FS-82 is similar to the Cb-1Zr alloy in performance but 33% tantalum has been added for oxidation resistance. Strength of both alloys, especially rupture strength, is similar. Oxidation resistance does not vary too extensively.

FS-82 is available in sheet from 0.010 to 0.080 in. thick. This, combined with excellent fabricability and weldability, presents the designer with an attractive package. FS-82 is one of the columbium alloys being evaluated for use in the leading edge of the Dyna-Soar reentry vehicle.

D 31 has a high titanium content

TABLE 3—SECOND GENERATION COLUMBIUM ALLOYS

Alloy	Composition, %							Condn	Tensile Properties				Stress-Rupture			Density, lb/cu in.	Recryst Temp, F	Developer
	V	Mo	Zr	W	Ti	Hf	Ta		Temp, F	Yld Str, 1000 psi	Ten Str, 1000 psi	Elong, %	Temp, F	Time, hr	Stress, 1000 psi			
B33	4	—	—	—	—	—	—	—	−148 73 2000 2400	74.2 59.5 30.3 13	91.7 81 33 13.7	31 32 34 55.4	2000	0.5	25	0.306	—	Westinghouse
B66	5	5	1	—	—	—	—	—	−148 73 2000 2200 2400	108 91 58 35 27	128 115 65 40 31	12 14 28 46 71	2200	0.9	27.5	0.305	—	Westinghouse
B77	5	—	1	10	—	—	—	—	−148 73 2400	137 106.5 27	159 132 30	20 18 34	2200	0.55 1.9 2.4	30 27.5 25	0.319	2700	Westinghouse
AS55	Proprietary							—	— — —	— — —	— — —	— — —	2000 2200	10 100 10	30 18 15	0.33	2200[f]	General Electric
FS-85	—	—	.5	12	—	—	27	Cold rolled[a]	70[a] 2000 2200 2400 2600 2800	95 41 — — 15 12	105 46 32 23 16 13	14 13 25 40 71 71	2000 2200 2400 2600	>158 10 10 10	17 19 13 10	0.39	2500	Fansteel
D 14	—	—	5	—	—	—	—	Cold rolled[b]	70 2000 2400 2500	62 27 14 12	78 35 16 15	15 35 112 120	2000 2200	100 100	12 5	0.31	2500	Du Pont
D 36	—	—	5	—	10	—	—	Recryst[c]	70 2000	71 22	80 23	21 50	—	—	—	0.252	2100	Du Pont
C 103	—	—	—	—	1	10	—	Cold rolled[d]	70 2000 2500 2700	88 18.2 10.5 7.3	93.5 26.4 11.6 8.1	9 63 >75 >73	—	—	—	0.32	2400	Wah Chang/ Boeing
C 120	—	5	1	15	—	—	—	Warm rolled[e]	70 2500	103 20	116 27	4 ~50	—	—	—	—	2700	Wah Chang/ Boeing
SCb-291	—	—	—	10	—	—	10	Cold rolled	2200 2600 3000	34.2 24 10.5	37.1 26.4 11.8	— — —	2730 2970 3200	2.5 2.4 2.1	7.8 5 3.8	0.362	2400	Stauffer Chemical Co.

[a]Str relieved 1 hr, 1832 F. [b]Str relieved 1 hr at 1750 F. [c]Recryst 1 hr at 2100 F. [d]Str relieved 1 hr at 1600 F.
[e]At 2050 F (jacketed), surface ground. [f]Recryst 50% after 1 hr.
Sources: Proprietary literature, private communication.

which contributes to its relatively good oxidation resistance (Fig 4) relative to the other columbium alloys discussed in this section. Since titanium additions over 5% tend to reduce strength, the net effect is development of oxidation resistance at the expense of load-carrying ability.

Fusion welding is difficult because the resulting joints are embrittled by a precipitation reaction. Although ductility can be restored by heating to 3500-4000 F and quenching, this treatment is not commercially feasible. Ductile joints have been made by resistance welding (where both temperature and time at temperature can be controlled) and by brazing (using a titanium shim as the filler between faying surfaces).

Cb-752 was developed by Union Carbide Metals Co. as Cb-74, and is now marketed by Haynes-Stellite under the newer designation. Oxidation resistance is not much better than that of pure columbium and high temperature components must be coated for protection. Strength is intermediate between those of D 31 and F-48 (see Fig 3), but on a strength-to-weight basis the alloy is almost equivalent to F-48 up to 2600 F.

Latest information from Haynes-Stellite is that the alloy can be fusion welded to produce ductile welds at room temperature—a valuable asset. Weldments were bent transverse to the weld over a 3 t radius through a 105-deg angle and free bent 180 deg without cracking.

F-48 is the highest strength first generation columbium alloy, and probably the highest strength alloy that will be developed for some time to come. It is also the most difficult alloy to fabricate. Weldments are not ductile, although heating to 2500 F in vacuum for 2 hr does restore ductility to the embrittled weldment. This treatment is not feasible for commercial structures.

Second generation alloys

The ten alloys discussed briefly in this section are new. Some of the information concerning them is sketchy but more data can be expected in the future.

Four trends are evident:

1. For all practical purposes, attempts to produce an oxidation resistant alloy that requires no protective coating have now been abandoned.

2. Strength is still an objective, but fabricability and weldability are now considered to be essential co-objectives of any alloying program.

3. Alloys are now being developed for specific forms such as tubing or forgings.

4. Use of interstitials (oxygen, carbon, nitrogen) to promote high strength levels has apparently been abandoned.

Wyman-Gordon Co.

***Forged** Cb-1Zr component weighing 1300 lb is 36 in. long. Ingot was melted first by electron beam, then by duplex vacuum arc.*

Columbium-Treated Steels

While columbium alloys have been making news, a less publicized but equally important use of columbium has been developing in the steel industry. Three years ago the steel industry began to market carbon and low alloy steels with small (up to 0.08%) additions of columbium.

What does this small columbium addition do? Briefly, columbium treated steels have a fine grain size and resist age hardening. Carbon and manganese content of the steel can be lowered, impact properties are improved, and the steels are more resistant to creep and rupture at elevated temperatures.

Properties and applications of the columbium-bearing grades will be discussed in a forthcoming article in M/DE.

The ten alloys coming up still must go through an evaluation period to determine whether or not they can be applied to components. At the present time, the relatively limited uses for columbium and its alloys mean that we will probably end up with one or two alloys for re-entry vehicles and one or two for tubing in space vehicle reactors and heat exchangers. Development of long-life coatings will expand the number of alloys that will be commercially significant.

Table 3 presents the compositions and selected mechanical and physical properties of the second generation alloys.

Except for C 120, the second generation alloys can be fusion welded to produce ductile joints. Strength is down from the high-water mark achieved by F-48, and oxidation resistance is developed by using adequate coatings. Strength levels generally have been raised over those of the weldable first generation alloys.

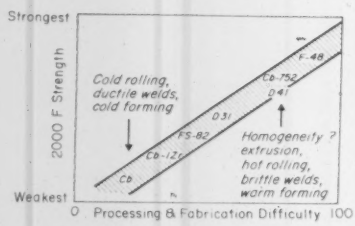
C 120, an electron beam melted version of F-48, is being developed in an attempt to increase fabricability at the expense of strength by lowering the interstitial content during melting. Weldability has not been fully determined at this time.

Forming and joining: fusion welding the real problem

The comparative rating of first generation alloys in Fig 5 shows that Cb-1Zr has the lowest rating and F-48 the highest relative to fabrication difficulties. Ductility of weldments made from one of the more easily fabricated alloys, FS-82, and the most difficult alloy, F-48, is shown in Table 4. Ratings of the newly developed second generation alloys are still being determined.

One of the advantages of columbium and its alloys is their relatively easy fabricability compared with molybdenum. Most producers agree that columbium alloys can be formed into complex shapes with relatively little difficulty at room temperature but that warm fabrication at 600 to 1200 F should be considered for complicated shapes. Some difficulty may be encountered if fabricating temperatures are raised too high. Although the three alloys shown in Table 5 are fabricable at room temperature, at 1200 F bend ductility decreases by a factor of up to 12.

Fabrication of columbium alloys in general constitutes no real challenge for the manufacturing engineer. The low ductile-to-brittle transition temperature—well below room temperature in many alloys—contrasts sharply with the high (200 to 500 F) transition temperature of molybdenum and tungsten-base alloys. Eliminating the brittle fracture problem goes a long way toward solving fabrication problems.



5 *Relative rating for processing and fabricating difficulties encountered with columbium alloys.* (Adapted from Jahnke.)

Despite the low transition temperature, if excessive oxidation is not avoided even the most ductile alloy, Cb-1Zr, becomes brittle. Table 6 shows how a radical increase in oxygen content affects bend ductility.

How newer alloys rate

Fabricability and weldability of first generation alloys have already been discussed briefly. Information concerning fabricability and weldability of second generation alloys is not generally available. Here are some data, many of which are published for the first time.

AS-55: A proprietary alloy developed by General Electric Co., its formability and weldability are presumed to be excellent. The alloy was developed specifically for tubing applications in space vehicle prime movers, and thus resists corrosion by liquid metals.

FS-85: This alloy was designed by Fansteel as a possible successor to FS-82. The aim was to develop an alloy that maintained the fabricability and weldability of FS-82 at higher strength levels. Bend ductility, an excellent measure of formability, is retained down to –320 F as the table below shows. Recrystallized weldments have been bent 89 deg at –110 F and 22 deg at –320 F.

Condn	Temp, F	Bend Angle, deg
Str Rel	40	120
	–80	119
	–100	119
Recryst	70	124
	–40	123
	–100	121
	–320	79

C 103: Ductile-to-brittle bend transition temperaure is > –320 F. Room temperature bend tests at 1t radius have been successful for a 120-deg bend angle. Embrittlement during recrystallization is not a problem. Specimens recrystallized at 2200 F and 2800 F have been bent around a ½t radius. Weldments should be stress relieved for maximum ductility.

C 120: So far, it has been determined that true hot rolling (above the recrystallization temperature) and forging are not commercially feasible. This high strength alloy may have to be fabricated between 800 and 1100 F but definitive bend ductility and weld ductility tests have not been completed.

D 14: This alloy is ductile at room temperature in the cold

TABLE 4—DUCTILITY OF FS-82 AND F-48 FUSION WELDMENTS

Alloy	Filler	Treatment[a]	Bend Angle, deg	Bend Rad, t	Location of Failure[b]
FS-82	FS-82	As Welded	104	3.1	None
		1900 F, 1 Hr	51	3.1	Weld
	FS-82	1900 F, 1 Hr, 1000 F, 2 Hr, Heated to 2100 F in Furnace, Held 1 Hr	102	3.1	None
F-48	Cb-1Zr	As Welded	16	6	Weld
		2200 F, 1 Hr	0	6	HAZ
		2500 F, 2 Hr	105	6	HAZ
	FS-82	As Welded	0	6	HAZ
		2200 F, 1 Hr	0	6	HAZ
		2500 F, 2 Hr	0	6	HAZ
	Cb-1Ce	As Welded	0	6	HAZ
		2200 F, 1 Hr	0	6	HAZ
		2500 F, 2 Hr	6	6	Weld

[a] All heat treatment in vacuum. [b] HAZ = heat affected zone.
Source: DMIC Memo 69.

Rudder and fin *assembly made from F-48 alloy is shown in welding jig. It is welded with FS-82 alloy.*

McDonnell Aircraft Corp.

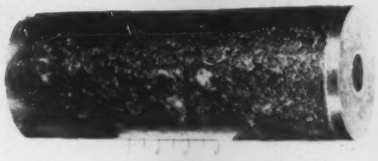
Fansteel Metallurgical Co.

Welded liner *for annealing furnace is produced from columbium sheet.*

Brooks & Perkins, Inc.

Columbium hemisphere *was spun from 0.063-in. sheet.*

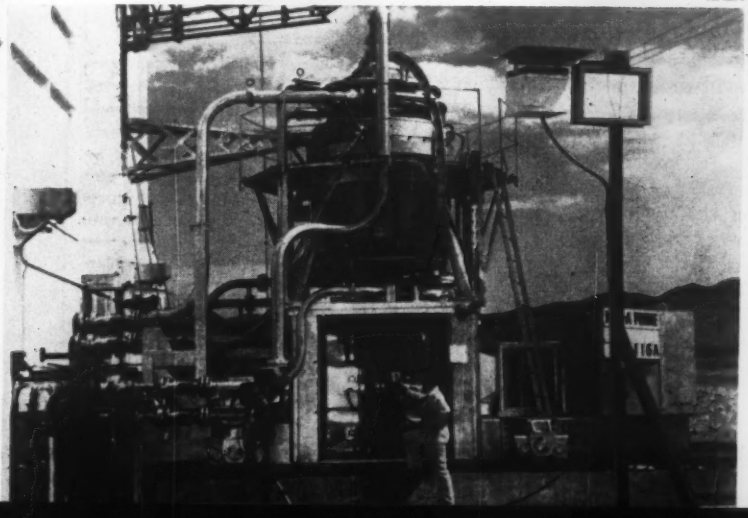
Westinghouse Electric Corp.



Tube blank, *the first columbium cast shape in the United States, was skull cast in 1957.*

Kiwi-A Prime, *one of a series of reactors studying the feasibility of a nuclear rocket. Use of columbium tubing is being considered.*

NASA



Fansteel Metallurgical Co.

Jet engine blade *forged from columbium.*

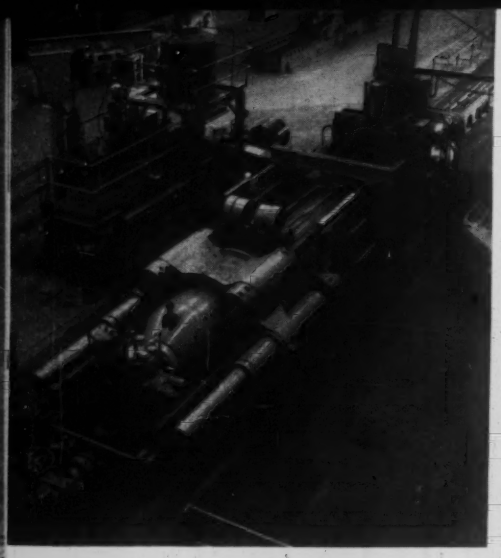


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TABLE 5—BEND DUCTILITY OF THREE COLUMBIUM ALLOYS

Alloy	Condn	Grain Direction	Min Bend Rad, t[c]		
			70 F	600 F	1200 F
FS-82 (0.02 in.)	Str Rel[a]	L	0.5	0.5	3
		T	0.5	0.5	4.2
	Recryst[b]	L	0.5	0.5	1.8
		T	0.5	0.5	1.8
D 31 (0.021 in.)	Str Rel[a]	L	0.5	0.5	5.7
		T	5.5	5.5	8.7
	Recryst[b]	L	>20	0.5	—
		T	>20	1	—
Cb-1Zr (0.022 in.)	Str Rel[a]	L	0.5	0.5	4
		T	0.5	0.5	6.9
	Recryst[b]	L	0.5	0.5	3.2
		T	0.5	0.5	3.2

[a] 1 hr, 1800 F. [b] 1 hr, 2400 F.
[c] Expressed as ratio of t, the material thickness. Bend angle 120 deg.
Source: R. T. Torgerson, "Evaluation of Forming Characteristics of Columbium Alloys," *Columbium Metallurgy*, Interscience, '60, p 31.

TABLE 6—HOW OXYGEN CONTENT AFFECTS BEND DUCTILITY OF COLUMBIUM ALLOYS[a]

Oxygen, %	Alloy	Sheet Thk, in.	Exposure; 4 hr, 1800 F
0.0005	FS-82	0.020	S[b]
	D 31	0.021	S
	Cb-1Zr	0.022	S
0.005	FS-82	0.020	S
	D 31	0.021	S[c]
	Cb-1Zr	0.022	S
0.4	FS-32	0.020	Brittle
	D 31	0.021	Brittle
	Cb-1Zr	0.022	Brittle

[a] Bend test to 120-deg angle at room temp.
[b] S = satisfactory bend.
[c] Satisfactory at 5t, cracks at 1t.
Source: R. T. Torgerson, "Evaluation of Forming Characteristics of Columbium Alloys," *Columbium Metallurgy*, Interscience, '60, p 31.

worked, stress relieved and recrystallized condition. It shows good weld ductility after tungsten arc inert-gas shielded (TIG) welding.

D 36: No definitive bend ductility data are available but room temperature ductility is good (up to 25% elongation for recrystallized sheet). Room temperature elongation of weld metal is 26%, an indication of good ductility.

B 33, B 66 and B 77: These Westinghouse alloys, now going into pilot plant production, are all considered formable and weldable. In the as-worked and stress relieved condition, B 33 was bent over a 1t radius at –320 F; B 66 and B 77 were bent over a 4t radius at –320 F. After recrystallization at 2700 F, B 33 was bent over a 1t radius at –320 F, while B 66 and B 77 were bent over a 4t radius at –100 F.

Other joining techniques

Resistance welding is being explored, but electrode sticking is a serious problem. Data are limited but it has been found that the introduction of titanium foil between faying surfaces increases the tensile shear strength of 0.040-in. F-48 sheets from 800 lb to 1080 lb. Thinner sheets (0.020 in.) show an even greater improvement: 500 lb without titanium foil, 900 lb with the foil.

No data are available for the second generation alloys.

Electron beam welding produces ductile weldments but the technique will probably be limited to small components.

Ultrasonic welding of columbium to dissimilar metals has produced welds with cracks at the edge of the bond areas (probably fatigue cracks induced by the high alternating stresses).

Brazing is still in its infancy for columbium alloys. The filler metals being explored are those that form no intermetallic compounds by diffusion alloying. Test data on FS-82 strip brazed in the form of double-lap tensile specimens with a titanium filler showed these failure loads:

Temp, F	Load, psi
70	7200
2200	1500
2500	1275
2600	660

Mechanical fasteners, an old standby, are the subject of several Air Force-sponsored programs. Basically, mechanical fasteners are considered undesirable for space vehicle programs for two reasons:

1. Fasteners add weight to the structure and thus tend to be self-defeating remedies.

2. Even more critical, perhaps, is the problem of developing a coating both for the fastener and structure to prevent oxidation at the joint-structure interface. Since there may be applications in which oxidation is not a problem, fasteners do have some potential, but their use will be limited.

Acknowledgment

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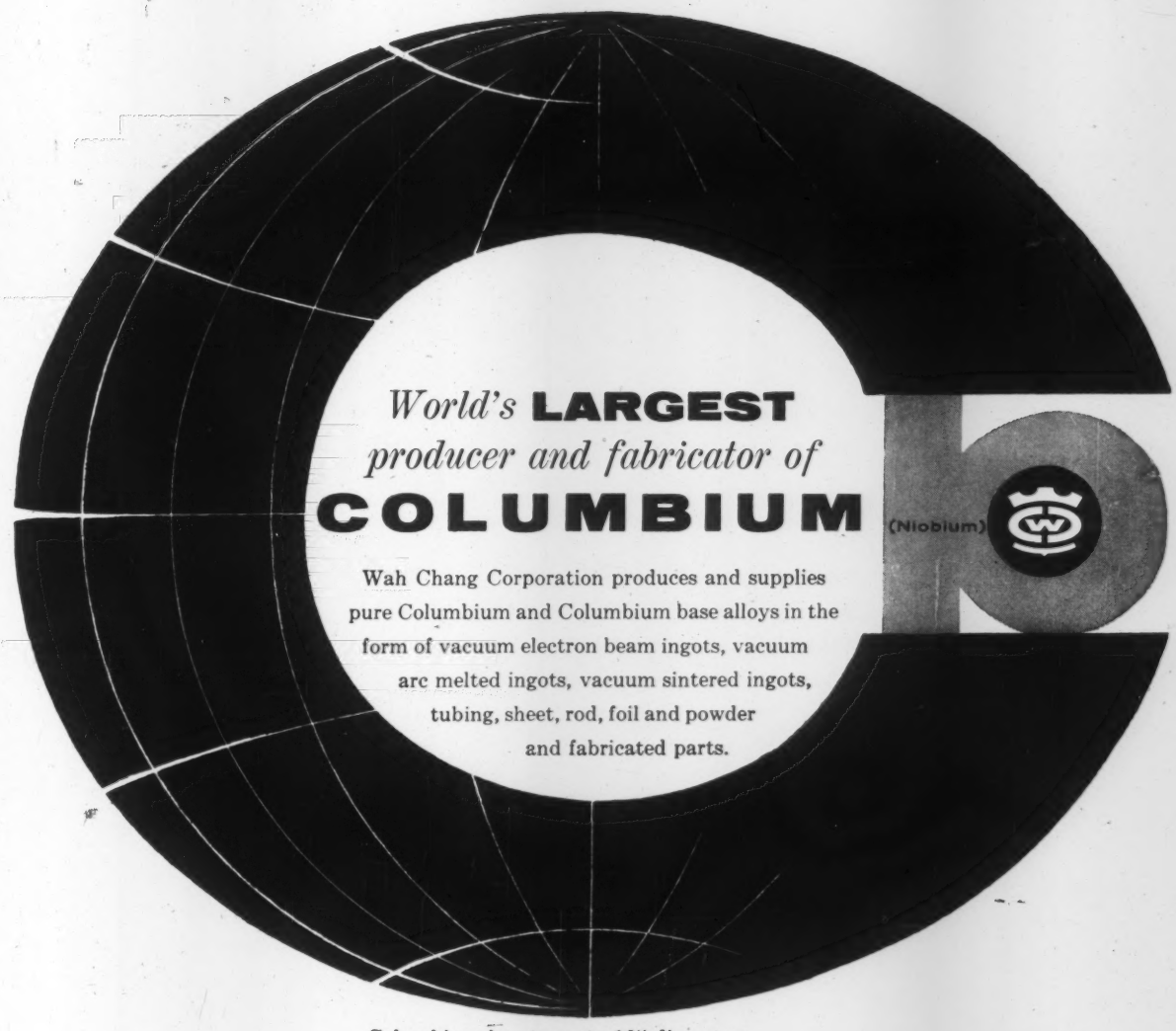
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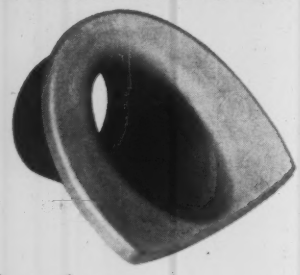

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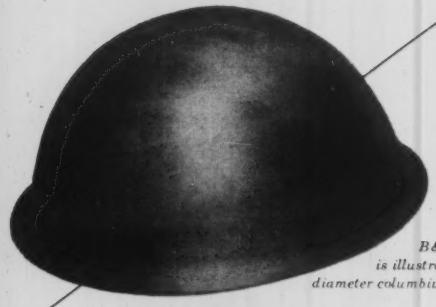
Columbium Experience



B&P's capability is illustrated by this 13" diameter columbium hemisphere.

WE HAVE IT

Lightweight and Space Age metals such as: Aluminum, Beryllium, Columbium, Magnesium, Titanium, Zirconium, are constantly being used at B & P. We have excellent facilities, along with years of experience in aircraft, satellite and missile assemblies. May we serve you?

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61-T-9

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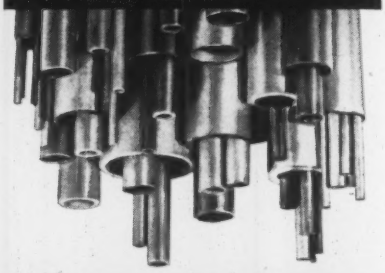
NOW



fine tubing in columbium and tantalum

You can now get fine, seamless tubing in columbium and tantalum from UNIFORM TUBES and profit from UNIFORM's standard policies of (1) top quality, (2) close tolerances, (3) fast delivery and (4) low prices. Drawn to your specifications with tolerances of ± 0.0005″ or better, columbium and tantalum tubing is available with any specified O.D. from 0.010″ to 0.500″. Wall thicknesses range from 0.065″ to 0.001″ with equally close tolerances.

Although drawn specially to your order, columbium and tantalum tubing will normally be shipped within 2 to 3 weeks.

This tubing is offered in random straight lengths to 20′ or cut to specific lengths, free of burrs. For subsequent ease of fabrication, tube lengths are fully annealed in vacuum furnaces. If you prefer, UNIFORM will fabricate columbium and tantalum tubular parts for you with the same skills and care that enable us to draw the original tubing to such close tolerances. Besides placing full responsibility with one supplier, you get the advantages of UNIFORM's low prices when tubular parts are fabricated "at the mill."

If you use or specify columbium or tantalum for their high-temperature strengths, corrosion resistances to hot acids, molten metals and metallic salts, or for their other outstanding properties, then write today for details on fine seamless tubing and fabricated parts of these rare metals.

UNIFORM TUBES, INC. COLLEGEVILLE 2, PA.
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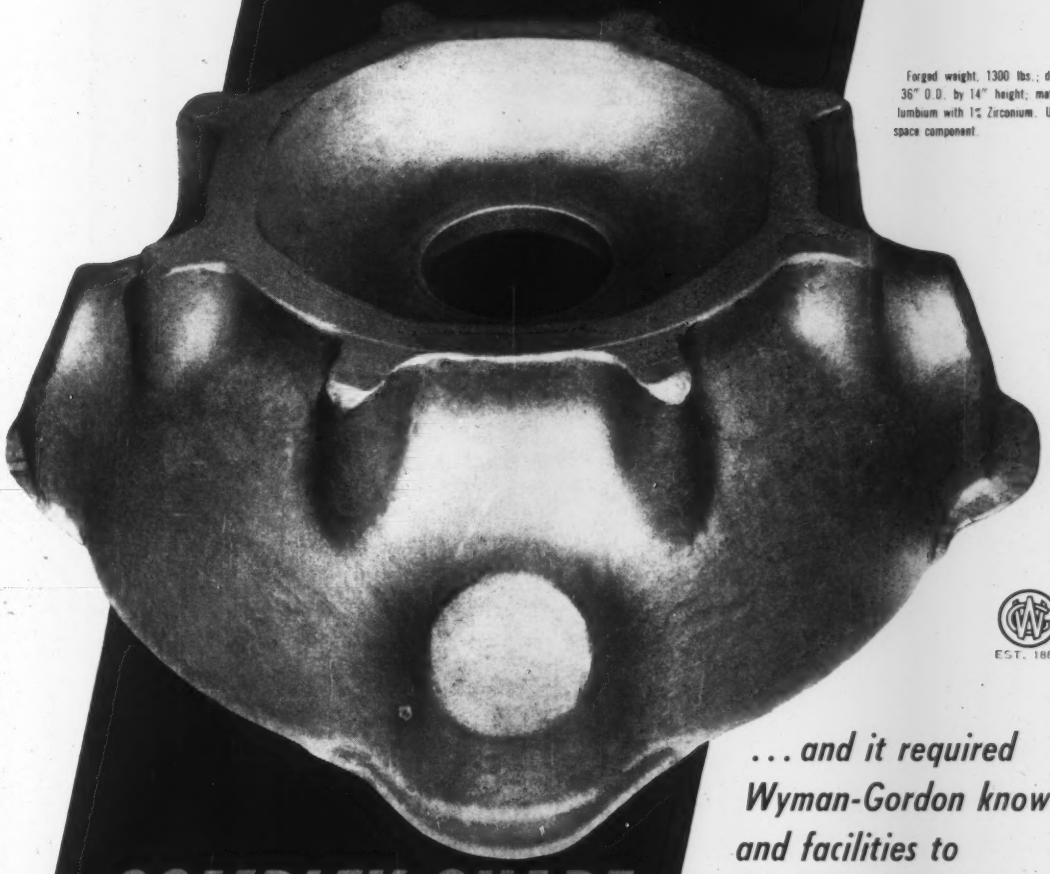
THIS 1300 POUND



Forged weight, 1300 lbs.; dimensions, 36" O.D. by 14" height; material, Columbium with 1% Zirconium. Use, aerospace component.

EST. 1883

. . . and it required Wyman-Gordon know-how and facilities to produce it successfully

COMPLEX SHAPE IS DIE FORGED OF COLUMBIUM

Impressive size and weight tell but part of the story on this Columbium forging "first." Its complex shape also marks a major breakthrough in giving this metal's distinctive properties broader design application. This development is typical of Wyman-Gordon progress in forging a growing list of presumed "impossible" materials—conventional and exotic as well as refractory. It underscores the research and metallurgical capabilities Wyman-Gordon can bring to successful solution of your forging design and materials problems.

SP-1

WYMAN-GORDON

FORGINGS

of Aluminum Magnesium Steel Titanium . . . and Beryllium Molybdenum Columbium and other uncommon materials

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DETROIT MICHIGAN LOS ANGELES CALIFORNIA PALO ALTO CALIFORNIA FORT WORTH TEXAS

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REFRACTOMET UC STEEL

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SINTERED MOLYBDENUM
FOR THE
CHEMICAL ELECTRONIC
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INDUSTRIAL HEATING
MISSILES AIRCRAFT
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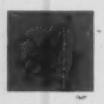

AVAILABLE FROM STOCK IN PRODUCT FORMS TO MEET YOUR NEEDS. Universal-Cyclops now adds sintered molybdenum mill products to its growing line of refractory metals. A leading producer of arc-cast molybdenum and its alloys, the company's Refractomet Division has adapted its years of experience and technical know-how in this area, to the production of sintered molybdenum.

The only integrated producer of molybdenum mill product forms, Universal-Cyclops now provides immediate delivery of sintered product, as well as arc-cast, in all mill forms—for every application in the chemical, electronic, electrical, glass, metalworking, industrial heating, missiles, and aircraft industries.

For complete information, write Refractomet Division or call your nearest district sales office.

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Price of lead has been reduced 1¢ per lb to 10¢, the lowest level in 15 years and the first change since last winter when it was cut 1¢ per lb to 11¢ (M/DE, Jan '61, p 103). Foreign competition is a prime factor behind the decline.

Production of polypropylene will be doubled at Texas Eastman Co.'s plant in Longview, Tex. New facilities now under construction and slated for completion in the last half of 1962 will bring the company's total production capacity to approximately 30 million pounds per year.

Steel plate up to 96 in. wide is now available from Alan Wood Steel Co. Widest plate previously available from the company was 72 in. The new 110-in. plate mill was recently completed as part of a $36 million expansion program which also included a 40-in. blooming mill.

A 10¢-per-lb cut in the price of a new wax additive has been put into effect by Du Pont. New truckload price is 45¢ per lb. The additive, called Elvax, is used to impart toughness and flexibility to paraffin wax coatings. It was introduced earlier this year (M/DE, Oct '61, p 162).

Availability of beryllium nickel strip in various sizes and tempers has been announced by Beryllium Corp. Previously, the metal was supplied only as ingots.

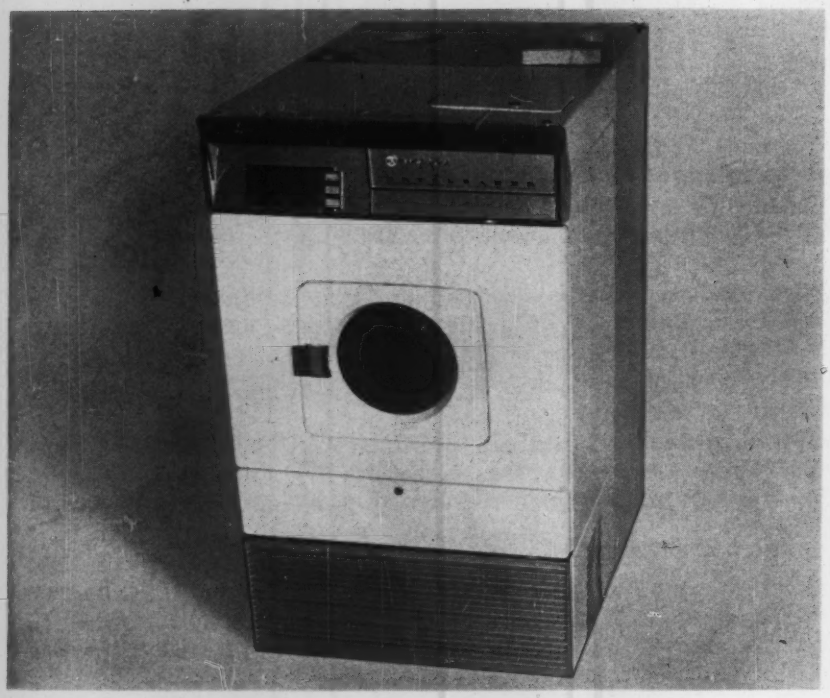
A 10 to 14% price cut on ABS plastics has been announced by Marbon Chemical Div. of Borg-Warner Corp. New truckload prices are: 42¢ per lb for natural grades, down 7¢ per lb; 51¢ for standard and custom colored grades, down 5¢ per lb; and 49¢ for metallic colored grades, down 5¢ per lb. The price action has been followed by other major producers.

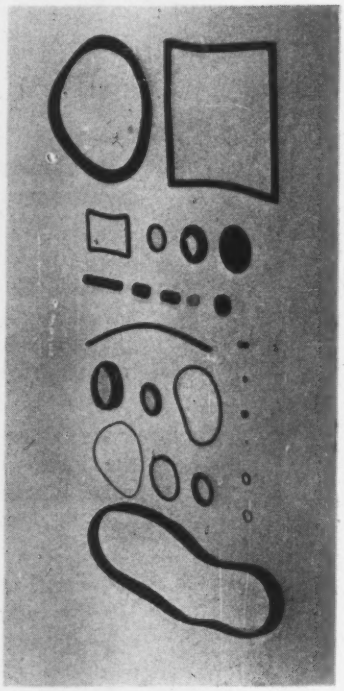
Stainless steel output for the first nine months of '61 amounted to 825,000 net tons, the highest since 1956 when 850,000 net tons were poured. And the September production of 117,000 net tons is the highest in 19 months, according to the American Iron and Steel Inst.

A price cut on modified acrylic fiber has been put into effect by Union Carbide Chemicals Co., Div. of Union Carbide Corp. New price for 3.0 and 6.0 denier Dynel fibers is 75¢ per lb, down 35¢ per lb; 12 denier is 70¢ per lb, down 40¢.

More vacuum melted metals will be available when Allvac Metals Co.'s new plant in Monroe, N. C. begins production early next year. The plant will be equipped with a new vacuum induction melting furnace capable of casting ingots up to 20 ft long. Capacity of the furnace is 10,000 lb per heat, described as one of the largest in the industry.

Why Engineers Selected VITON® as Material "X" for the RCA Whirlpool Dry Cleaning Machine





Twenty-five parts (right) are made of VITON to withstand solvent and high heat

Whirlpool Corporation engineers solved staggering problems in developing a foolproof coin-operated dry cleaning machine. One of these problems was searching for a Material "X" that would withstand constant attack by the cleaning solvent.

Perchlorethylene ruins flexible seals, gaskets, tubes and valves made with conventional materials. The compact machine's six separate systems (electrical, mechanical, air flow, solvent, refrigeration and coin), make many additional elastic components necessary for insulation and damping.

In these applications, ordinary rubber stiffens, swells and breaks down in a matter of days.

"We tested many materials," reports Robert K. Sykora, director of engineering for Whirlpool's commercial laundry and dry cleaning equipment division. "One by one they were eliminated until VITON synthetic rubber was tried.

"We found that VITON not only withstands perchlorethylene, high temperatures and general wear, it retains its resilience and tensile strength despite prolonged use. And VITON doesn't bleed color when exposed to the hot perchlorethylene vapor . . . a most important feature where clothing is involved."

VITON defies a host of other rubber-destroying fluids as well, including fuels and lubricants. Special compounds can function all the way up to *600° F.* If your design problem involves resilient seals, O-rings, diaphragms, or hoses that must function under extraordinary conditions, you should check VITON.

For details and a list of reliable rubber manufacturers who can engineer VITON parts to meet your needs, write E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MDE-12, Wilmington 98, Delaware.

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VITON®
SYNTHETIC RUBBER

Better Things for Better Living . . . *through Chemistry*

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MATERIALS ENGINEERING & DESIGN

(continued from p 102)

Two-Inch Titanium Welded in Sub Study

Successful crack-free welding of 2-in. thick titanium alloy plates has been reported by Battelle Memorial Institute. Previously, ⅝-in. titanium plates were the thickest that had been welded, and these had suffered extensive joint cracking.

Base plate yield strength of 120,000 psi plus notch toughness of 20 ft-lb at a temperature of –80 F—and joint properties at least this good—are the tentative goals of a research project the institute is carrying out for the Bureau of Naval Weapons. These objectives have not been achieved completely but it appears likely that they are attainable.

Deep-dive submarines

The Navy is exploring the possibility of using titanium plate in the construction of submarine hulls. The strength-to-weight ratio of this material, which is considerably higher than that of the steels used presently, could allow increased speed, payload and diving depth.

Success in obtaining crack-free joints was judged to be a result of careful shielding; all welding was done in an argon-filled chamber.

Experimental welds were made in plates with a double-vee joint design using an automatically controlled consumable-electrode process. Welding conditions of 365 amp, 32 arc volts and a 15-ipm travel speed produced a heat input of about 45,000 joules per in.

New welding filler

Although all joints tested fell short of one requirement or another, the best combination of yield strength and impact properties was obtained with Ti-6Al-4V alloy plates and an experimental Ti-5Al-2Cb-1Ta filler wire.

The Ti-6Al-4V composition showed the most promising properties in tests of several candidate materials for use as base plate. It had a yield strength of 117,000 psi and a notch toughness of about 15 ft-lb at –80 F. The Battelle group working on this project feels that notch strength could be raised to an acceptable level by reducing oxygen content in the alloy.

The experimental Ti-5Al-2Cb-1Ta filler wire had a toughness of 40 ft-lb at –80 F. Yield strength was 104,000 psi, and it was felt that this could probably be improved by raising the aluminum content of the alloy. Commercially available filler materials proved to be inadequate, especially in impact properties.

Polypropylene Outlasts TFE on Some Jobs

Using polypropylene in place of Teflon in electrical insulators for certain caustic processing tanks has greatly extended the service life of these parts. This application is one of several noteworthy instances where Humble Oil & Refining Co. has advantageously replaced Teflon with polypropylene (Escon, supplied by its Enjay Chemical Co. division).

The parts support and insulate 25,000-v electrical components in Varsol processing tanks. When made of Teflon they deteriorated and finally failed, allowing electrical arcing and tracking to occur within an average time of 24 days. Failure was attributed to chemical corrosion, aggravated by the high voltage drop across the insulators. The much less expensive polypropylene replacements for these insulators are reported to have lasted 290 days and to be still giving good service.

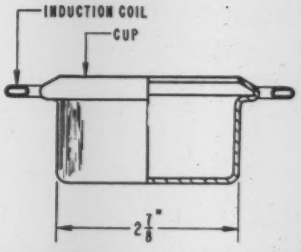
Two other cases where replacing Teflon with polypropylene has im-

LepeL
HIGH FREQUENCY Induction HEATING UNITS

Lepel induction heating equipment is the most practical and efficient source of heat developed for numerous industrial applications

Typical Induction Heating Applications

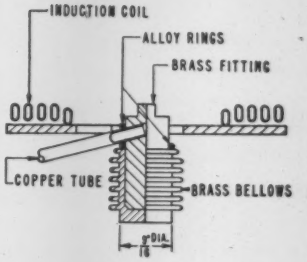
Stainless Steel Cups Selectively Annealed



Flanges of cups made from type 321 stainless steel are selectively annealed by induction heating prior to further forming. Flanges are heated to 2000° F and water quenched. Single-turn coil restricts heating to the flange area.

Our engineers will process your work samples and return the completed job with full data and recommendations without cost or obligation.

Bellows Assembly Brazed



Brass bellows and copper tube are simultaneously silver-alloy brazed to a brass fitting by induction heating. Plate-type induction coil produces proper temperature at each joint.

WRITE FOR NEW LEPEL CATALOG

LepeL HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.
CHICAGO OFFICE: 6246 WEST NORTH AVE.

For more information, circle No. 340

proved performance and life:

- Teflon gaskets in a phenol atmosphere showed a history of leakage due to cold flow of material during joint tightening. Gaskets made of polypropylene retain their shape; they have eliminated the leakage and can be reused several times, field experience shows.
- The same refinery has also turned from Teflon to polypropylene for belt scrapers. In this abrasive duty, the service life of the scrapers has been increased five-fold.

Epoxy Seals Vacuum at High Temperature

*by K. S. Balain**

An epoxide casting resin maintained an effective vacuum seal on a furnace that was cycled from room temperature to 1020 F in a recent Westinghouse research program.

The resin, Stycast 2762 (produced by Emerson & Cuming, Inc.), was used to seal penetrations of electrical and thermocouple leads into the furnace. Internal pressure was held at 10^{-4} mm Hg for testing intermetallics. The furnace flange at the point of penetration reached a temperature of 480 F.

Conventional seals failed

We found commercially available seals to be unsuitable for this duty. Those made of glass surrounding a solid metal pin produced large emf's due to temperature differentials. Seals made of metal tubes held in a ceramic matrix were cumbersome

* Semiconductor Dept., Westinghouse Electric Corp.

LET MUELLER MAKE IT!

Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its *men, methods* and *metals* . . . Mueller is in the unique position of being able to offer true single source service.

MUELLER HAS THE MEN . . . experienced engineers with the ability to work out, creatively, tough design problems, and improve a part or components for production by the most economical method. You get sound engineering plus 45 years of practical metalworking production experience when you "Let Mueller Make It."

MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

MUELLER HAS THE METALS . . . and the materials . . . to produce precision parts in aluminum, brass, bronze, copper, iron, and steel in hundreds of different alloys to meet each exact requirement.

In addition, Mueller Brass Co. has complete and modern facilities for performing all types of finishing and sub-assembly operations. Another plus value is nation-wide sales engineering service.

So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers . . . and no matter where you're located, it will pay you to LET MUELLER MAKE IT!

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High Purity CRUSHABLE CERAMIC PREFORMS meet Government Specs.

Crushable ceramic preforms for precision swaged thermocouples for atomic energy and turbine engine applications are available from Carborundum.

The following materials exceed the requirements of A.E.C. Specification SPC-SR-101-(ORO), Oak Ridge National Laboratories Specification ORNL Spec. 7444-1 and Knolls Atomic Power Laboratories ORPM 7-1.

1. *High Purity Magnesium Oxide*—Type 0333, certified purity 99.4% min. MgO and less than 25 ppm boron.
2. *High Purity Fused Aluminum Oxide*—Type 1513, certified purity 99.6% min. Al_2O_3 and less than 2 ppm boron.
3. *Stabilized Zirconium Oxide*—Type 0956, certified purity 91.9% min. and less than 10 ppm boron.

Standard sizes are from .022 O.D. with holes from .005. Standard preforms are offered for 1, 2 and 4 hole applications. Others are available on request.

For Technical Data Sheet and other information contact Dept. MD-121, Latrobe Plant, Refractories Division, Carborundum Co., Latrobe, Pennsylvania.

CARBORUNDUM®

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MUELLER CAN MAKE MOST ANYTHING IN BRASS OR ALUMINUM FORGINGS...

Battleships are not our business, but we can make any practical size and shape forging, including cored forgings and those with bosses or cavities on two planes. (The ship model is made up from a number of production forgings.)

Special alloys are available or can be developed to meet nearly any metallurgical requirement. These include "TUF-STUF" aluminum bronze . . . "600" Series bearing bronze . . . silicon bronze . . . manganese bronze . . . aluminum alloys . . . and many, many others.

Rod for forging blanks is extruded in our own mills. We also produce our own tools and dies and maintain complete machining and finishing facilities.

You are assured quality forgings backed by the more than 45 years' experience of the world's largest producer of brass, bronze and aluminum forgings when you

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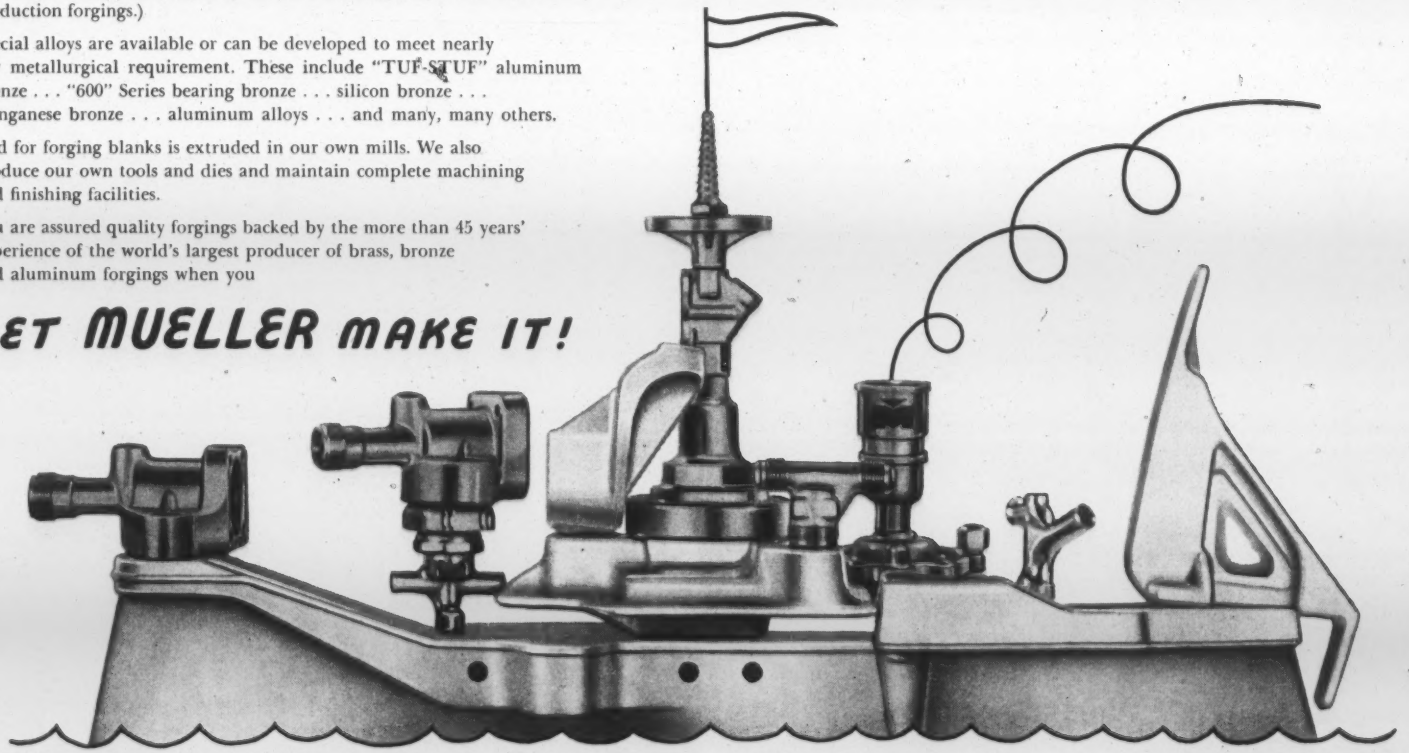

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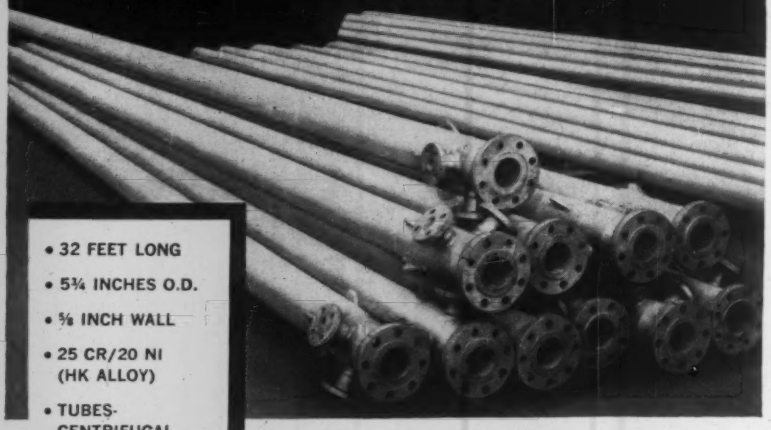

- 32 FEET LONG
- 5¾ INCHES O.D.
- ⅝ INCH WALL
- 25 CR/20 NI (HK ALLOY)
- TUBES-CENTRIFUGAL
- FLANGES-STATIC

Alloyed to give both corrosion and heat resistance

Two of our three Casting methods are well illustrated in this photograph: centrifugally cast tubes and statically cast flanges. The finished assemblies, including the welding, typify the work turned out in our modern finishing shop.

These tubes are alloyed to meet exceptionally high temperatures—up in the 1800°F range—as well as corrosion. As a matter of fact, we have an alloy (HOM) that is good for even higher temperatures—in the 2100 to 2200°F plus range. When corrosion is the dominating problem we can offer alloys throughout the complete "C" classification.

With forty years of alloy casting experience plus complete range of both heat-resisting and corrosion-resisting alloys plus facilities for finishing and assembling, Duraloy is in a strong position to take care of your high-alloy casting requirements. Ask for Bulletin G-261.

DURALOY

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HOUSTON OFFICE: 4101 San Jacinto, Houston 4, Texas

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and we had considerable difficulty in making them vacuum-tight.

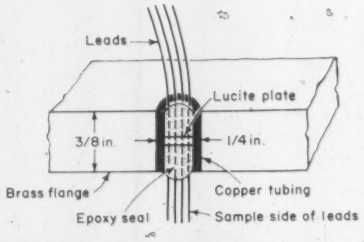
Because the coefficient of thermal expansion of Stycast 2762 closely matches that of copper, seals made of this material survived several temperature cycles at pressures down to 10^{-4} mm Hg. This compound showed excellent adhesion to metal and negligible shrinkage during cure.

Seal construction simplified

The resin facilitated the construction of a seal which included eight leads as shown in the accompanying drawing.

The first step in constructing the seal was silver soldering a sleeve of ¼-in. copper tubing to the brass furnace flange. A thin sheet of acrylic plastic, with holes for the leads, was then press-fitted in the center of the tubing to insulate the leads when the seal was made. Just before making the seal we thoroughly cleaned the leads, tubing and acrylic plate.

The upper half of the tubing was then filled with resin. We put the assembly through a cure of 6 hr at 300 F and 18 hr at room temperature, and repeated the procedure for the other half of the tubing.



***High temperature epoxy** provides a vacuum seal for eight electrical leads in one penetration.*

Stainless Steel Jackets Shield Pipe Insulation

The strength, fire resistance and chemical resistance of stainless steel make it far superior to conventional materials used to jacket piping insulation.

This is the judgment of Union Carbide Metals Co. as a result of tests performed on stainless steel and alu-

For strength
. . . economy
. . . versatility

Steel

NO LARGER GENERATOR SHAFT EVER FORGED ANYWHERE

Shipped recently to the General Electric Company's Large Steam Turbine Generator Department at Schenectady, N. Y., this shaft weighs 233,865 lb and measures 38 ft, 9½ in. long. The shaft will be machined and assembled by G. E. for a turbine-generator unit to serve Tennessee Valley Authority's Paradise Steam Generating Station at Paradise, Ky.

The 116-ton shaft was forged from a 120-inch diameter ingot that required the combined output of five electric-furnace heats, or roughly 260 tons of vacuum-poured, nickel-moly-vanadium steel. It was the largest ingot ever cast in a vacuum by Bethlehem. No larger generator shaft has ever been forged.

The generator shaft was fully heat treated and sonic tested. It has a maximum body diameter of 59¼ in.; minimum diameter of the forging is 11¼ in. The generator will operate at 1800 rpm, providing a maximum output of 391,111 kva.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

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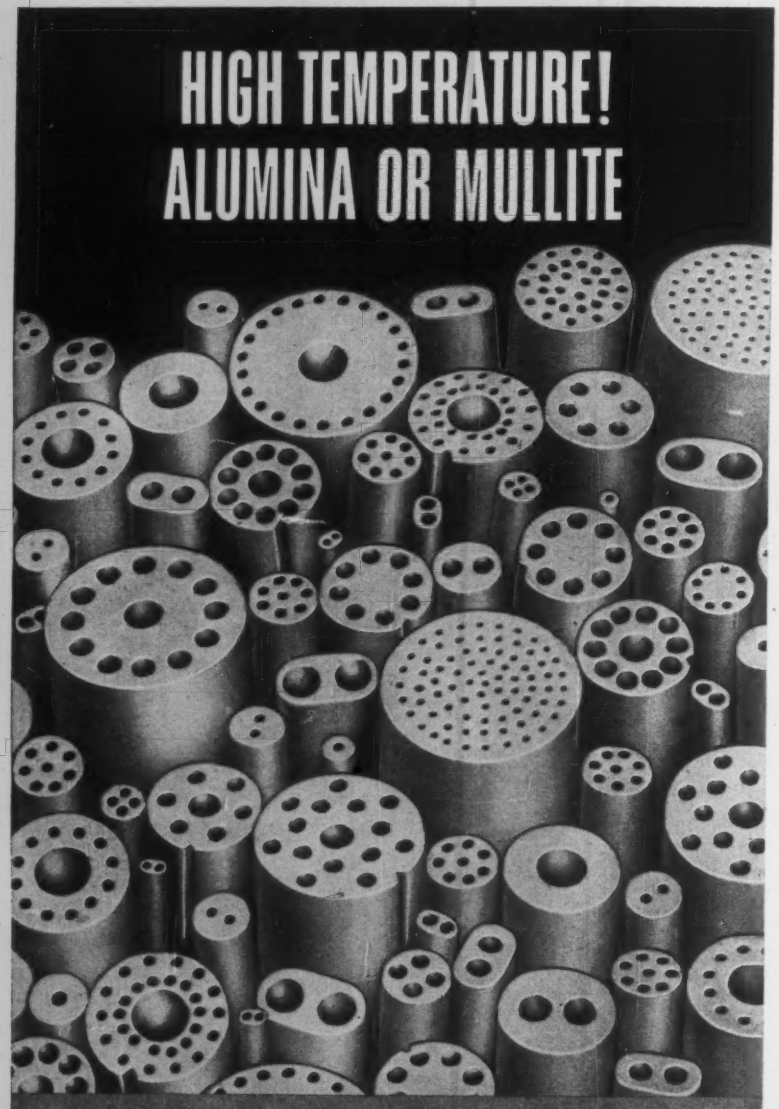

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High-temperature ceramic insulators! Sizes .020 and larger! 1-inch, 2-inch and 3-inch lengths! Special sizes, shapes and lengths and multiple bore quickly available.

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McDANEL Industrial CERAMICS

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REFRACTORY PORCELAIN COMPANY
BEAVER FALLS · PENNSYLVANIA

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minum. The company selected type 304 stainless for 20,000 sq ft of pipeline at its West Virginia plants.

Corrosion resistance

Corrosion resistance is one of the principal requirements of jacketing. Moisture from the weather outdoors, and from condensation indoors, constantly threatens to damage jacketing and permeate insulation, making it ineffective. Tests showed that both stainless steel and aluminum resist moisture corrosion satisfactorily. The choice between the two depends on their other properties.

Stainless steel has excellent strength for performing the basic functions of insulation jacketing: protecting insulation from mechanical damage, and keeping it moisture-free.

In checking for resistance to chemical corrosion, aluminum was found to resist acids but not caustics; stainless steel resists both.

Fire resistance

Stainless steel affords fire protection in an indirect way. Most chemical industry fire fighting authorities require high temperature insulation to protect piping against fire for a full hour. However, insulation compositions cannot withstand the force of high pressure fire hose streams. Stainless steel jacketing, with its high melting point, can remain solid while in direct contact with flame for over an hour, and thereby keep the insulation intact.

Pipelines containing hot fluids can present the danger of flesh burns to personnel if jacketing temperature becomes too high. Stainless steel, with a greater emissivity than aluminum, results in a lower surface temperature.

Jacket preassembled

These advantages were embodied in the stainless steel jacketing made by Johns-Manville Corp. for Union Carbide Metals Co. Insulation and jacket are preassembled at the factory to simplify installation. The semicircular halves mate by means of longitudinal slip joints, and circumferential seams are covered by stainless steel bands lined with a non-setting sealer. For piping that has tracer lines attached for heating,

ARE YOU ACQUAINTED WITH THE NEWEST ADDITION TO UNION CARBIDE'S FAMILY OF PLASTICS

BAKELITE®
POLYPROPYLENE

High heat resistance

No stress cracking

Lowest specific gravity

Outstanding flex life

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Good mechanical, electrical and chemical properties

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(All formulations except food grades are heat stabilized for prolonged use at elevated temperatures)

GENERAL PURPOSE: for molding and extrusion.

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FOOD APPLICATIONS: FDA-sanctioned

HIGH FLOW: for deep-draw moldings

U-V STABILIZED: for outdoor applications

BLOW MOLDING: short flow for parison stability

THERMOFORMING: non-sagging

We would be glad to discuss polypropylene or any of our other plastics materials with you. These include high, medium, and low density polyethylene, polyethylene copolymers, phenolics, styrene, epoxy and vinyl resins and compounds. Simply fill out the adjacent coupon.

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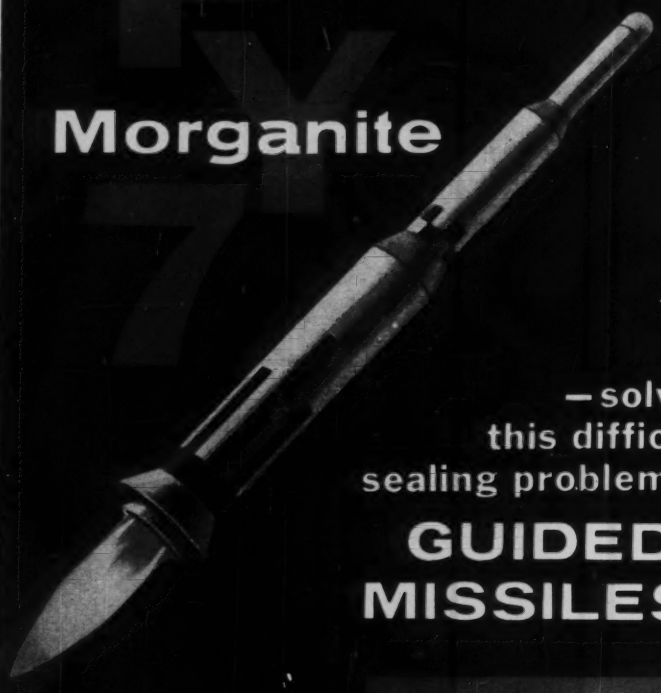
Morganite



—solves this difficult sealing problem in

GUIDED MISSILES!

Morganite PY7 Seals provide high reliability in this missile application where premium performance is essential due to severe environmental conditions. Combustion gases at 900°F are on one side, oil at low temperature on the other. Speed is 3600 R.P.M., face load 20 lbs. and mating surface is stainless steel.

Specify Morganite for all seal requirements. Ask Morganite engineers for a recommendation on your specific applications. Morganite seals assure longer life in the presence of grease, searching liquids, corrosives, high pressures and high temperatures. Call or write for complete data, today — please address inquiries on company letterhead.

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Manufacturers of Fine Carbon Graphite Products including Mechanical Carbons, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts — Distributors of 99.7% Pure Al_2O_3 Tubes, Crucibles and Crusilite Electric Heating Elements.

3324 48th Avenue, Long Island City 1, New York

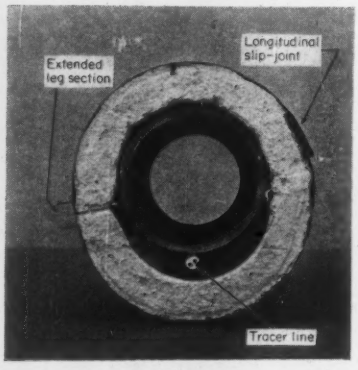
In Canada: Morganite Canada Ltd., Toronto

For more information, turn to Reader Service card, circle No. 323

the insulation and jacketing are made with an "extended leg" to include the tracer lines (see photo).

The installed cost of this jacketed insulation is said to be 8% higher than that of the common weather-jacketed installation with a field-applied, fire resistant mastic, and less than a third higher than that of an installation with an aluminum jacket.

Development work is being done to arrive at economical methods of producing fitting covers of stainless steel.



***Preassembled** insulation and jacketing of the extended-leg design.*

Fast Circuit Printing with Heated Die

Production savings from 10 to 40% and greater design latitude for printed circuits are said to be offered by an ingenious die stamping technique.

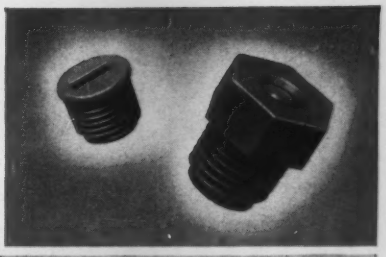
The process centers around heated dies which stamp out electrical circuits from conductive sheets and simultaneously reactivate an adhesive which bonds the circuit material to a baseboard. The dies, developed by Resources and Facilities Corp. of New York City, thus promote mass production by integrating two operations.

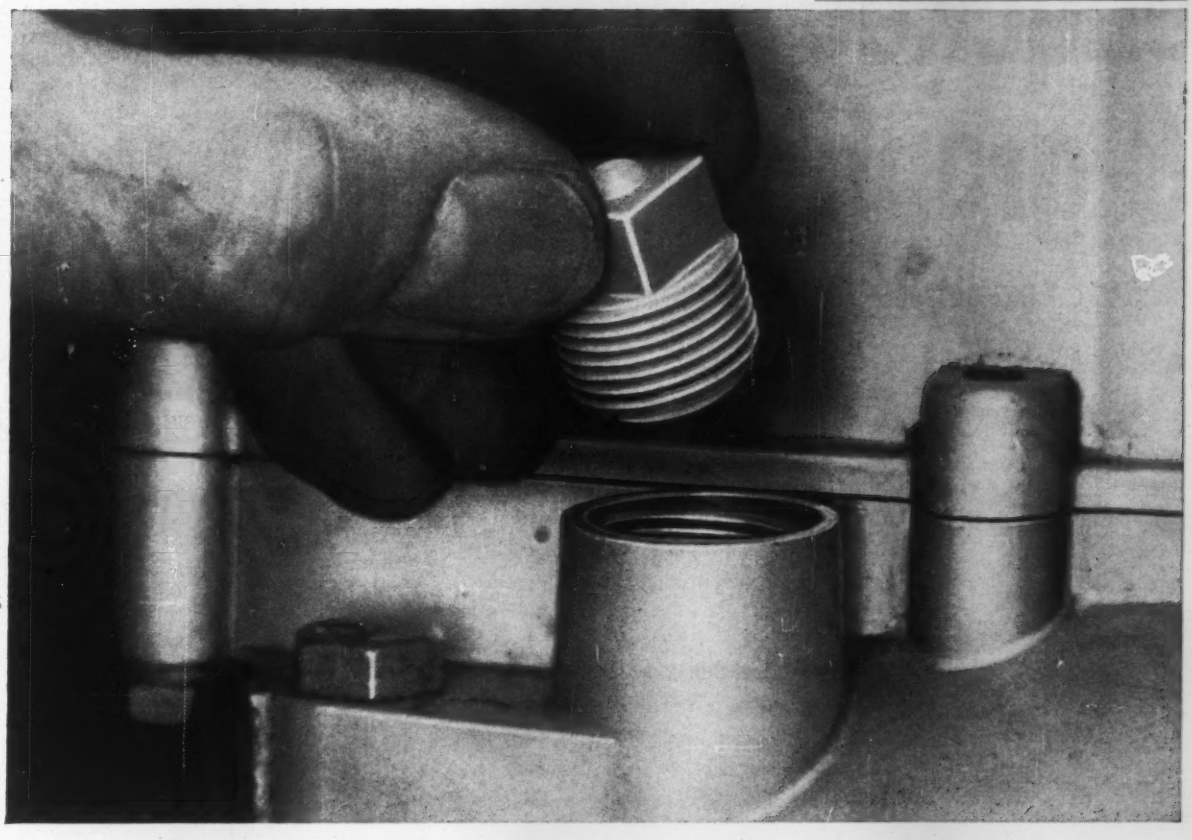
Production speed up

A manufacturer of electronic circuits has exploited the advantage of the process using copper sheet that has been precoated with adhesive and dried to a nontacky state. The

New, complete line of

RB&W molded plugs





Avoid damage to threaded holes...get leakproof seal, too

You entirely eliminate the risk of damaging a costly tapped hole with RB&W molded plugs. If inadvertently crossed-threaded, their plastic material yields to metal threads—especially important where the tapped holes are in malleable metals.

They seal tightly under pressure, too. That's because all RB&W plastic plugs are molded hollow. Fluids under pressure exert radial forces that expand threads for an even tighter, dry, plastic-to-metal contact.

They resist corrosion, usually cost less than their metal counterparts, are available in various materials for various jobs.

DELRIN®—All-purpose RB&W Delrin® plugs ideally seal gases or fluids in compressors, pumps, valves, pneumatic and hydraulic systems, or any service involving contact with petroleum derivatives. Delrin plugs have metal-like mechanical properties, are suitable for use to 250°F.

NYLON—Made from *heat-stabilized* nylon (Zytel® 103), RB&W plugs withstand temperatures exceeding 300°F, remain leakproof at working pressures to 3000 psi.

NYLON—Made from *hydrolysis-resistant* nylon, (Zytel® 2281), RB&W plugs assure dependable service when continuously exposed to hot water or vapor.

POLYETHYLENE—RB&W polyethylene plugs, in two head styles, economically seal threaded openings to exclude dirt, contaminants, and moisture during shipping or handling. They can be tightened with fingers or wrench.

Send for data sheet which gives sizes and other specifications. Write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

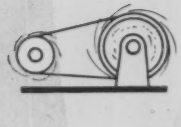
® du Pont trademark

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

For more information, turn to Reader Service card, circle No. 369

Have you checked carbon & graphite's MANY "MECHANICAL ADVANTAGES" LATELY?

for High Temperature Work—As bearings or seal rings, several specially-formulated Stackpole grades provide long life and low friction up to 1200°F—temperatures where more costly and exotic materials often fail.



for High-Speed, Unlubricated Uses—In terms of life, maximum speed, and low friction, Stackpole carbon & graphite offer many performance dividends over even more costly self-lubricating bearing and seal ring materials.

Handling Chemicals & Gases—Inert Stackpole carbon & graphite resist attack in all but the most highly oxidizing atmospheres at normal temperatures.

Under Thermal Shock—Stackpole carbon and graphite materials will not spall, crack, melt or seize in difficult refractory applications.

STACKPOLE

Stackpole Carbon Company, St. Marys, Pennsylvania

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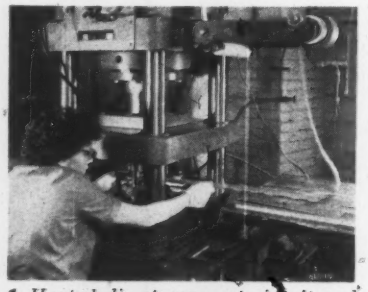
For more information, turn to Reader Service card, circle No. 365

sheet, produced by Rubber and Asbestos Corp. of Bloomfield, N. J., is fed from a roll into the stamping press, where it is mated with a strip of baseboard material (Fig 1).



***1** Heated die stamps out circuit and bonds it to baseboard.*

***2** Stripping excess metal away leaves completed circuit pattern.*

After the hot die has stamped the circuit pattern and bonded the desired areas of metal to the baseboard (typical dwell time for bonding is 2 to 10 sec), excess metal is stripped away manually, leaving the finished circuit pattern (Fig 2). Dytronics Inc., Rochester, Mich., makes these circuits for missile systems.

The process is a completely dry one. It precludes damage to baseboard materials from chemical solutions. The avoidance of etching chemicals permits selection of baseboard composition from a broader range of materials because chemical resistance is not required.

Higher capacity circuits

Design capabilities appear to be greater for circuits made by stamping than for those made by etching. In addition to being able to choose from a wider range of conductor

For more information, circle No. 372 ➤

Computer Analyses Now Make Tenzaloy Better Than Ever

Asarco has introduced another significant advance in aluminum casting alloy technology — computer correlation of composition and properties of its widely used high-strength, self-aging Tenzaloy. Results: Further refinement in quality and reliable performance of this superior alloy.

Data for the pioneering computer analyses were drawn from a long record of properties and composition of Tenzaloy plant heats compiled by Asarco's Central Research Laboratories. From these studies has come new knowledge of the interaction of Tenzaloy elements and effects of alloying ingredients on mechanical properties.

Computer findings now enable Asarco metallurgists to control Tenzaloy mechanical properties to a much narrower range of variation and to higher average values than ever before — and to reproduce them precisely and consistently over and over. There is only one Tenzaloy and it cannot be duplicated.

TYPICAL PROPERTIES OF TENZALOY

	SAND CASTINGS	PERMANENT MOLD CASTINGS
Tensile Strength	35,000 psi	40,000 psi
Yield Strength	25,000 psi	27,000 psi
Elongation (in 2")	4-5%	6-7%
Brinell Hardness No.	74	74
Impact Strength (Charpy in ft./lbs.):		
Notched	3	3
Un-notched	14	20
Electrical Conductivity	30%	30%

Tenzaloy can widen design horizons, increase production efficiency, reduce costs and improve your products. For your copy of Bulletin 103R5, "Tenzaloy, the Self-Aging Aluminum Casting Alloy," write today to: Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y.

ASARCO

TENZALOY

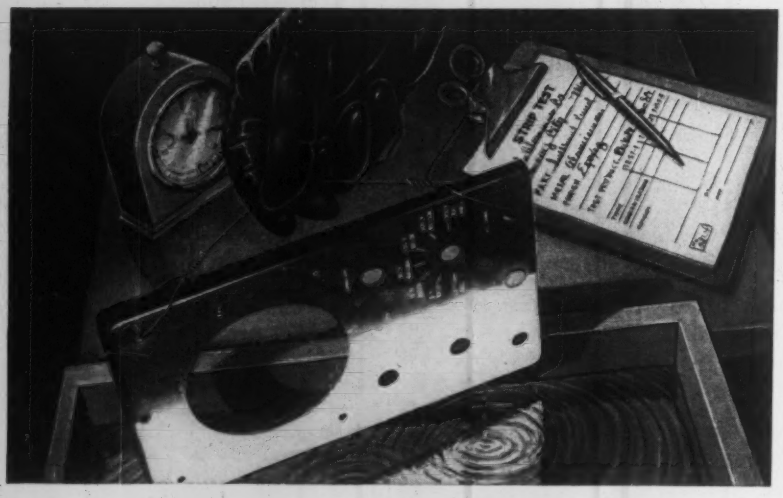
For more information, circle No. 372

Burroughs B205 computer correlates unique composition and properties of Asarco's high-strength Tenzaloy.

For safe stripping of aluminum

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS



Strip anything from aluminum even epoxies . . . with complete safety

Salvage expensive aluminum parts *safely* in a tank of Oakite Stripper S-A. It strips the toughest finishes in minutes, with no danger of etching the aluminum beneath. Saves the part . . . saves *you* costs.

Stripper S-A works faster than almost anything else you can try on paints, lacquers, coatings and adhesives, including the new epoxy, acrylic, vinyl and polyester types . . . yet, it's completely safe for such metals as steel, stainless steel, copper and brass as well as aluminum. Has no flash point, works without heat.

And Stripper S-A is only one of a long line of Oakite stripping compounds for safe reclamation of rejects. There are strippers for maximum economy . . . for maximum speed . . . for *any* method of application. ASK THE OAKITE MAN. Or write for Bulletin F-7893, Oakite Products, Inc., 25A Rector Street, New York 6, N. Y.

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years' leadership in industrial cleaning

For more information, turn to Reader Service card, circle No. 367

metals, the designer can create printed circuits with thicknesses up to 15 mils. Etched circuits are usually limited to thicknesses of 4.2 mils. The increased cross section area of conductor metal is said to permit the design of circuits with over 40 amp capacity—about twice the usual limit for etched circuits.

The stamping dies can produce circuit patterns with extremely accurate registration and consistent duplication. The stamping technique avoids the hazards of line breaks and undercutting which etchants can cause, and appears to minimize the possibilities of human error.

Molybdenum Improves Steel for Abrasive Duty

Additions of molybdenum to austenitic manganese steels increase their abrasion resistance, according to a study conducted by Climax Molybdenum Co. Two alloys of this family were found to have excellent endurance when subjected to different types of abrasion.

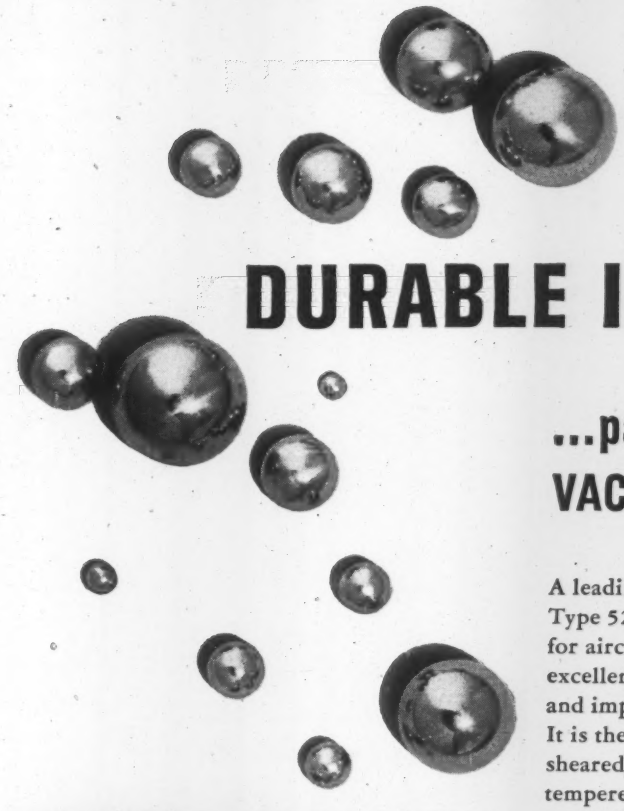
1. Steel containing 12% manganese and 2% molybdenum showed 50% longer service life than standard Hadfield steels in this investigation. The high percentage of manganese in this steel makes it suitable for use under high-impact gouging abrasion. (The dispersed carbides in this composition would generally prevent its use under medium impact grinding abrasion.)

2. A molybdenum-stabilized 6Mn–1Mo steel has the fully austenitic structure and low manganese required for medium-impact grinding abrasion. This material is reported to be comparable to the Ni-Hard irons in resistance to this type of wear.

Increased carbon content

Alloying with molybdenum also permits an increase in carbon content without producing embrittlement. This is said to prolong the useful life of these steels even more. Increased carbon content, with the accompanying increase in abrasion resistance, has been restricted in the past because it also produced carbides which cause brittleness.

Strong,
Modern,
Dependable



DURABLE IN THE EXTREME

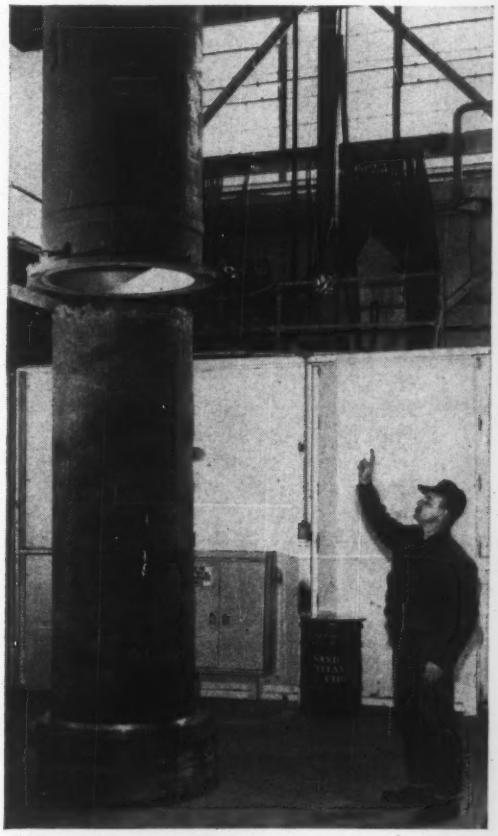
...parts produced from Republic VACUUM-MELTED Metals

A leading manufacturer of ball bearings uses Republic Type 52100 Vacuum-Melted Alloy Steel in bearings produced for aircraft and missile applications. This steel provides excellent resistance to erosion, corrosion, abrasion, and impact. The alloy is supplied to the manufacturer in bars. It is then drawn into wire rods, annealed, drawn to size, sheared into slugs, forged, heat treated, rough ground, tempered, finish ground, and polished.

Produced by the consumable electrode process, Republic Vacuum-Melted Metals offer higher mechanical properties—ductility, tensile strength, and longer fatigue life—with nonmetallic inclusions reduced in number and size. Republic can deliver these metals in quantity on time, and in a wider range of sizes and conditions than ever before possible.

Our metallurgists will quickly help you select, apply, and process vacuum-melted metals: *super alloy steels, constructional alloy steels, high strength alloy steels, bearing steels, stainless steels, titanium,* and *special carbon steels.* For complete information, contact your nearest Republic sales office or write Republic Steel, Dept.ME-1842-A, 1441 Republic Bldg. Cleveland 1, Ohio.

SUPER ALLOY STEELS • CONSTRUCTIONAL ALLOY STEELS • HIGH STRENGTH ALLOY STEELS • BEARING STEELS • STAINLESS STEELS • TITANIUM • SPECIAL CARBON STEELS

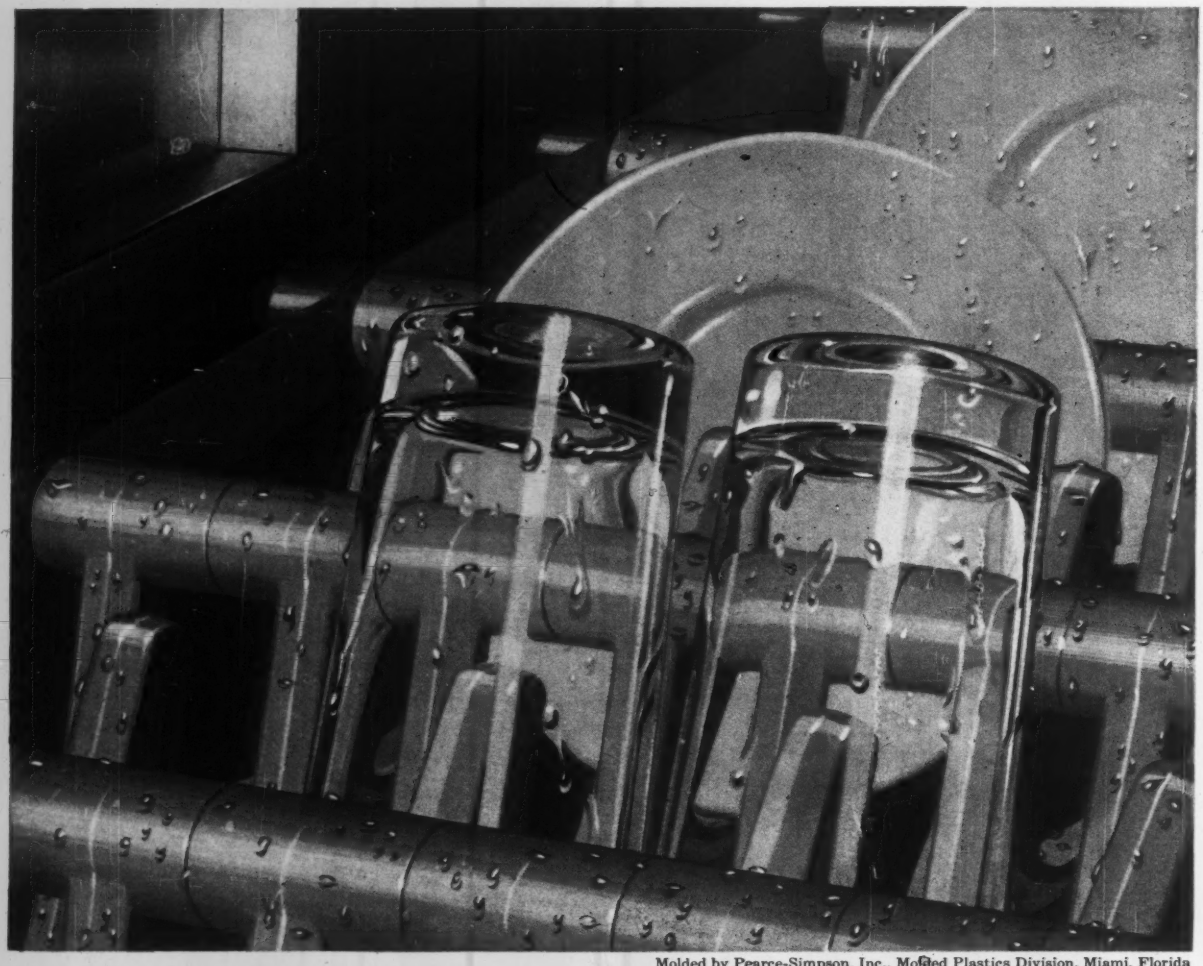


REPUBLIC VACUUM-MELTED METALS are produced in 18- to 32-inch diameter ingots weighing from 4,000 to 20,000 pounds. These can be processed into billets, sheets, bars, strip, and wire to meet your precise requirements.

REPUBLIC STEEL

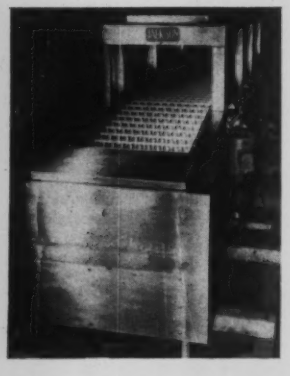
Republic Has The Feel For Modern Steel

For more information, turn to Reader Service card, circle No. 393



Molded by Pearce-Simpson, Inc., Molded Plastics Division, Miami, Florida

Dishwasher cradles of Escon® polypropylene defy high heat and detergents



The Jackson Products Company of Tampa, Florida, chose Escon polypropylene for the conveyor-belt cradles on its new flight-type dishwasher. Resistance to high heat and detergents was the overriding reason. Of all materials considered (including metals and other plastics), Escon best withstood the punishing chemical attack of wetting agents found in commercial dishwashing compounds.

The resilience of Escon creates a cushioning effect which minimizes breakage, while its negligible water absorption contributes to long life. And with Escon, cradles can be made in a variety of contrasting colors.

Properties like these point to Escon polypropylene as the ideal choice for many demanding applications. To find out more about this versatile material, write to Enjay, 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY

For more information, turn to Reader Service card, circle No. 333

(cont'd from p 15)

withstand high, sustained surface tension stresses, particularly in the transverse and short transverse (thickness) directions. (See M/DE, Apr '61, p 139 for a discussion of this problem.)

According to Dr. Kent Van Horn, Alcoa's Director of Research, tests on 7075–T73 show that the alloy can now withstand sustained tensile stresses equal to 75% of the yield strength in all directions. Formerly, this stress level was restricted to stress in the longitudinal direction. It could be applied in the transverse direction with caution and could not be used in the short transverse direction at all.

Not a replacement—The new –T73 temper supplements but does not replace the –T6 temper. If high sustained surface tension stresses are not encountered in a transverse direction then –T6 remains the better choice because of the higher mechanical properties it offers. The table presents the minimum mechanical properties established by Alcoa for the –T73 temper in sections 3 in. or less in thickness.

Can be licensed—A patent application has been made by Alcoa for the –T73 temper and a policy for issuing licensing agreements has been established. Details are available at 738 Alcoa Bldg., Pittsburgh 19, Pa.

For more information, circle No. 605

Three New Silicone Rubbers

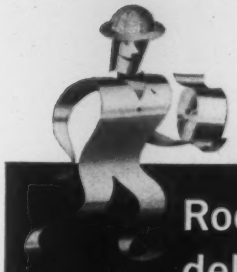
Three new silicone rubbers—a low temperature compound, a room temperature vulcanizing foam and an easy-processing compound—have been introduced by two companies.

***Expansion** of Dow Corning's new silicone rubber foam begins 30 sec after catalyst addition. The foaming action is complete 5 min after catalyzation.*

KW-1920 is a silicone rubber-base compound that combines low temperature flexibility at —120 F with good resistance to oils and other fluids. The compound is available from Union Carbide Corp., Silicones Div., 270 Park Ave., New York 17. It is expected to be used for seals, diaphragms and gaskets. **KEY NO. 611**

Silastic RTV S-5370 is a low density, silicone rubber foam that vulcanizes at room temperature. Developed by Dow Corning Corp., Midland, Mich., the material is supplied as a fluid silicone rubber base with a separate catalyst. When base and catalyst are mixed together in the proper proportions, expansion and vulcanization begin immediately. The reaction takes place entirely at room temperature, and expansion is completed 3 min after the catalyst is added. At the end of this time, the rubber has expanded to approximately seven times its original volume. After an additional 2 min, the foam is rubbery and can be handled.

The silicone rubber foam is serviceable from —70 to 500 F and has good electrical properties. Potential



Rodney delivers
THIN STRIP and FOIL

Precision Thinness in Stainless and Special Alloys...

Rodney concentrates its entire efforts, research and production, toward furnishing super thin, extra wide, precision rolled, metal strip and foil in all tempers and finishes. With the entire capacity of plant and personnel devoted exclusively to this specific area, Rodney can offer the added "know-how", manufacturing experience, quality control, and application knowledge your operation may require.

Rodney produces stainless steel strip . . . all alloys . . . in widths from ⅛" to 24" . . . at gauges from .012" to .0003". Rodney also rolls high temperature alloys and other special alloys on a production basis. Aluminum alloys, carbon steel strip and specialty custom rolling are also handled.

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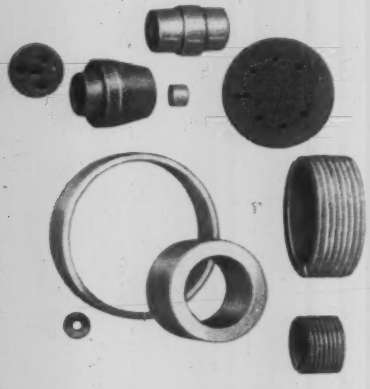
For more information, circle No. 399

ARE YOU FACING A MATERIAL BARRIER?



DIAMONITE ALUMINA CERAMIC parts are breaking material barriers for manufacturers of mechanical, electro-mechanical and electronic products daily.

Spray drying of the formulation and air conditioning of the area where the batches are prepared have resulted in an exceptional purity and uniformity of the finished product.

These improved facilities, coupled with Diamonite's continuous kiln firing, assure the presence of the physical and dielectric strength with low loss factors expected of alumina products. Diamonite is vacuum tight and readily metallized.

Design engineering service with a specialties department for prototype models assures you of highest reliability factor in this material.

Get all the facts—write or phone today for your copy of "Technical Ceramics for the Electronics Industry."

DIAMONITE

Shreve, Ohio Dept. M-12

Phone: JOseph 7-4211

For more information, circle No. 426

uses include thermal and vibration insulations. KEY NO. 612

Silastic 241U is an easy-processing silicone rubber available from Dow Corning that bands readily on mill rolls without crumbling and requires very little mill softening. Finished parts can be made by molding, extruding or calendering.

The compound is designed to meet the 40 Durometer hardness requirements of MIL-R-5847D, Class 2A and 2B; AMS 3301 C; and MIL-STD-417, Type T, Class TA 405 B3 and E3. KEY NO. 613

Pure Cobalt Strip Has Good Ductility

Pure cobalt strip with good ductility and workability has been introduced by Sherritt Gordon Mines Ltd., 25 King St. West, Toronto 1, Canada. The strip is supplied in thicknesses ranging from 0.005 to 0.025 in. and in widths from ¼ to 6 in. It sells for $4.40 per lb.

Cobalt has excellent magnetic properties, and one promising application for the strip is magnetic tape for computers. The cobalt strip is twice as strong as nickel strip and retains its strength at elevated temperatures; corrosion resistance is about the same as that of nickel. Properties of the strip are given in the accompanying table.

PROPERTIES OF COBALT STRIP

Coef of Ther Exp, per °F	7.8×10^{-6}
Ther Cond (70 F), Btu/hr/sq ft/°F/in	479
Density, lb/cu in.	0.32
Melting Point, F	2700
Tensile Strength, psi	
Cold Reduced 25%	165,000
Annealed	115,000
Elongation, %	
Cold Reduced 25%	0.5
Annealed	15

The new strip is rolled directly from 99.9% pure cobalt powder in a three-step process: 1) powder is cold compacted in a vertical rolling mill to form a green strip 6 in. wide, 0.060 in. thick and 70-80% dense; 2) the green strip is sintered in a hydrogen atmosphere; and 3) the sintered strip is hot rolled to reduce thickness about 30%, then cold rolled to a 25% reduction. KEY NO. 614

Noted briefly in our November issue.

Urethane Coatings Require No Mixing

A new series of coatings are said to be the first pure polyurethane coatings to offer clear or pigmented, hard or flexible versions in a one-part system. Called Chemglaze, the coatings are available from Hughson Chemical Co., Div. of Lord Mfg. Co., Erie, Pa.

The new coatings are said to combine the advantages of oil-modified types (application ease, good stability and short drying time) with the features of two-part systems (durability, and good physical and chemical properties).

Resist dirt pick-up

The coatings have good resistance to wear, impact and abrasion, as well as to ozone, chemicals and solvents. Surfaces finished with the coatings have the ability to resist dirt pick-up. The coatings remain stable for one year or more in an unopened container and from two to seven days in an open container. They can be applied by brushing, dipping, flowing and spraying.

The coatings can be used over wood, metal, glass and plastics parts; chemical process equipment and tank cars are two typical applications. Evaluation samples are available at $3 per pint. KEY NO. 615

Noted briefly in our November issue.

Thermal Insulation

A new high temperature insulation, described as being virtually pure carbon, is available as fibers and as a fabric from H. I. Thompson Fiber Glass Co., 1733 Cordova St., Los Angeles 7. The fabric is sold in rolls 33 in. wide and 50 yd long.

Called Hitco-C, the material has successfully undergone rocket firing

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **High-impact phenolics for shock environments**
- **Fast forming with thermosetting resins**
- **Fire retardance plus in structural plastic**

Better impact strength

The reverse clutch cone pictured here is molded of Durez 16771, a high-impact phenolic material made with fibrous glass. The cone does duty as a brake against which the steel ring gear of a planetary train is stopped while the transmission is under full power.

In this application, the part is buffeted by murderous static and dynamic friction, developed heat, and the 5000-lb. force of the actuating piston. It must also do battle with the chemical effect of transmission oil.

The test performance proved that the phenolic part does a better job than metal in all respects. You would therefore expect it to do equally well in other shock environments—and you'd be right. A few examples: stud-welding gun, rocket nozzle, compressor support, motor end-bell, washer sheave, missile nose cone.

Durez 16771 abounds in unique advantages, the most valuable of which is its refusal to warp or shrink. You can mold parts to exact dimensions, without needing to allow for shrinkage.

If *you'd* like a closer look at the properties and design advantages of high-impact phenolics, we'd like to send you a reprint of an article written for *Product Engineering*.

A resin that forgets

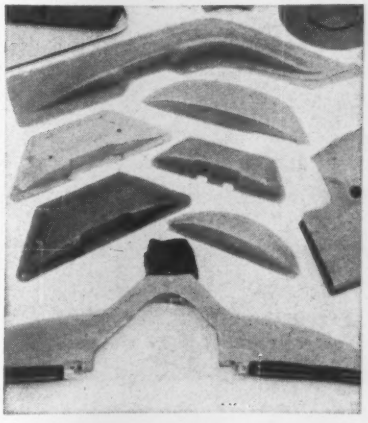
Forgetfulness is a virtue in this material.

It is a prepreg, commonly called "forming board," made from kraft fibers in which Durez phenolic resin has been dispersed as binder. The producer of the prepreg, whose name we'll be glad to send you on request, supplies it in thicknesses ranging from .060 to .150 inch, and in sheet sizes to 55 x 72 inches. A sheet can be stored two years at 70° F without losing its usefulness.

Squeezed at 300-500 psi in a hot press, the prepreg "sets" within 5 to 15 seconds to become a strong, rigid molded shape that will withstand moisture, heat and mild corrosives.

This is where forgetfulness comes in. There is no springback or "memory" effect in this forming board, because as it cures the resin changes its chemical nature to become a different substance, one of great durability.

As you might suspect, there are



many other uses for Durez thermosetting resins of interest to almost anyone developing new products. To get a better idea of how their interesting properties might help you, check the coupon for Bulletin D102, a 12-page idea book.

Delight for designers

Structural paneling which incorporates Hetron® polyester resin in its manufacture is proving a boon to designers concerned with safety and strength . . . a delight to decorators seeking the attractions of color and translucence.

Hetron paneling is fire-retardant. It does not sustain combustion. It offers the added benefits of light weight, unbreakability, resistance to corrosion and to climatic extremes. It has high strength-to-weight ratio, excellent impact strength and finishing properties.

Other applications of Hetron range from auto fenders to portable hangars for jet aircraft. To enrich your knowledge of this versatile material, we'll gladly send you our Designer's Data File and the names of fabricators.

For more information on Durez materials mentioned above, check here:

- ☐ High-impact phenolic molding material (reprint of article)
- ☐ Thermosetting resins (12-page Bulletin D102)
- ☐ Hetron fire-retardant polyester resin (data file and fabricator list)

Check, clip and mail to us with your name, title, company address.

DUREZ PLASTICS DIVISION

1412 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

For more information, turn to Reader Service card, circle No. 405

LUBRICATION REPORT

(dry film coating)

Application: *Lock Part Pre-Assembly Lubrication.*

Problem: *Find a quicker, cleaner method of lasting lubrication.*

Solution: *dag ® Dispersion 154 — diluted in equal parts with denatured alcohol.*

RESULT: *CLEANER, MORE UNIFORM, LONGER-LASTING LUBRICATION ON LOCK PARTS*

Cam retainers and disc tumblers used in American Hardware Corporation's padlocks are 1/2 by 1/4 inch brass stampings. Because of their small size, this New Britain, Conn. manufacturer has found dipping to be the most efficient method of lubricating them. Acheson's 'dag' 154 proved to be ideal for this operation. Its alcohol carrier quickly evaporates, leaving a permanent film of graphite on the parts. This microscopically thin film is deposited uniformly, adheres tenaciously, and will not rub off during lock assembly. Since it does not attract dust and discourages oxidation and corrosion of the brass parts, 'dag' 154 provides a longer, smoother operating life for the locks.

For more information on the advantages of Acheson dry-film lubricants in product design, send for your copy of Bulletin No. 435. Write to Dept. ME-121.

ACHESON – First name in solid lubricants for fifty-four years.

ACHESON Colloids Company

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

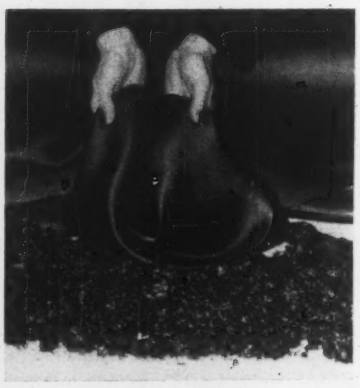
Sales offices in principal cities

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

For more information, turn to Reader Service card, circle No. 408

tests and is now being designed into critical areas of several rocket engine components. Potential uses include electrical insulation; filters for corrosive liquids and vapors; and dry, non-lubricated bearings, gaskets and packings.

Compared to other carbonaceous materials, the new insulation has lower thermal conductivity. It has a low ablation rate when combined with phenolic resins, according to the developer. Warp breaking strength is 25 psi. **KEY NO. 616**



Fibers and fabric *of new carbonaceous material are expected to be used in a variety of high temperature applications.*

Clear Polyester Tape for Class 265 F Use

An 0.001-in thick, clear polyester film coated on one side with a transparent thermosetting pressure sensitive adhesive has been introduced by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Called Scotch brand electrical tape No. 54, it is designed for continuous operation at Class 265 F (formerly Class B) temperatures. Typical applications include coil cover and interlayer insulation slot liners, slot edging, and capacitor and transformer insulation.

The tape has a dielectric strength of 4500 v and a tensile strength of 30 psi. Its insulation resistance is 1×10^6 megohms.

The transparent adhesive is said to resist most solvents, waxes, var-

progress through creative research in **ADHESIVES** *COATINGS... TREATMENTS...*

DESIGNER'S GUIDE TO CHEMLOK® ADHESIVES

Chemlok 220/203 . . versatile adhesive system for bonding uncured elastomers to rigid substrates.

System bonds natural rubber, SBR, butyl, neoprene and nitrile —during vulcanization—to all metals, many plastics. Uniform high-strength bonds reduce rejects. Wide manufacturing tolerances cut costs. One coat of 220 outperforms most two-coat systems; 220 over 203 gives unmatched environmental resistance. Economical, high-quality bonding has made these the most widely used rubber-to-metal adhesives. **Request Bulletin No. 2012.**

Chemlok 301 . . general-purpose structural epoxy adhesive.

This adhesive seals and fastens in one operation. It joins any combination of metal, glass, wood, fabric, ceramic, plastic, rubber and foam sponge. Removes potential leakage areas and points of stress concentration associated with mechanical fastening holes. High-strength bonds erase welding or soldering cost; permit use of lighter, cheaper materials. Chemlok 301 cures at room temperature with contact pressure, offers handling ease plus exceptional resistance to oil, chemicals, moisture and weathering. **Request Bulletin No. 3501.**

Chemlok 607 . . high-strength, high-temperature adhesive for speciality elastomers.

Adhesive bonds uncured silicone, Hypalon, Viton A, Fluorel and other speciality elastomers to metals, glass, fabrics, or plastics. Exceptional bond strength at temperatures to 500°F. improves product versatility. One-coat application saves time, equipment and expense. Chemlok 607 provides environmental resistance equivalent to the stock, unique strength/temperature ratios. **Request Bulletin No. 6005A.**

Chemlok EX-B150-1 . . .
speciality adhesive for elastomer-to-elastomer bonding during vulcanization.

EX-B150-1 forms durable, high-strength bonds between butyl, neoprene, natural, SBR and nitrile stocks. Bond flexibility permits prolonged exposure to heat and flexure without loss in dynamic properties or strength. EX-B150-1 aids in manufacture of rubber products where two or more elastomers are bonded to form a superior composite part. **Request Bulletin No. 5009.**

Chemlok EX-B579-1 . . .
RTV silicone rubber adhesive.

One-part, one-coat speciality adhesive bonds room-temperature-vulcanizing silicone rubber to metals, ceramics, glass, plastics and cured epoxy resins. Bond is formed during cure. EX-B579-1 offers processing ease with all commercially available RTV silicone rubbers, produces rubber-tearing bonds with excellent environmental resistance to broad temperature conditions. **Request Bulletin No. 6006A.**

For better bonding at lower cost, investigate Chemlok Adhesives.
Write for complete technical details and evaluation samples.

HUGHSON CHEMICAL CO.
A Division of Lord Manufacturing Co.
Erie, Pennsylvania

hughson

HUGHSON CHEMICAL CO., Erie, Pa.
Please send me technical bulletins:

____ 2012. ____ 3501. ____ 5009. ____ 6006A. ____ 6005A.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State____

For more information, turn to Reader Service card, circle No. 407

the ACCURATE WAY to test MICRO and MACRO hardness

Wilson TUKON hardness tester

• Wilson TUKON testers make and measure extremely shallow indentations. They are used, for example, by manufacturers of watches, hairsprings, needles and jewels. In laboratories, TUKON instruments test individual crystals or microscopic particles. On any job, they provide these important advantages:

Accuracy—Precision-built TUKON testers give consistently correct results. Loads are applied without friction or impact—Bausch & Lomb optical equipment is standard—vibration is closely controlled.

Long life—Simple design, rugged construction make TUKON testers as durable as a machine tool.

Easy operation—Even an unskilled operator can get perfect readings after a short training period.

Supplied complete—Special accessories for various sizes and shapes.

A complete line of Wilson Rockwell instruments is available, including semi and fully automatic models.

Wilson "Brale" Diamond Penetrators Each diamond is cut to an exact shape. A comparator check and microscopic inspection of each diamond assure perfect readings every time.

Write for details—Ask for Catalog RT-58. It gives complete information on the Superficial tester as well as on the full line of Wilson Rockwell hardness testers.

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 370

nishes and chemicals. It will not soften at high temperatures or "throw out" when used in high speed rotating equipment. The adhesive provides high tack and good initial adhesion for holding and protecting parts during production. **KEY NO. 617**

Improved CFE Resin Makes Uniform Parts

More uniform, higher quality CFE parts are said to come from an improved CFE (chlorotrifluoroethylene) resin now available from Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. The resin, called Kel-F 81, is sold in two grades based on molecular weight.

The resin is claimed to have: 1) thermal stability from –400 to 400 F, 2) good abrasion resistance, 3) good resistance to a wide range of chemicals, fuels and corrosive media, 4) excellent electrical properties, 5) good infrared transmission properties, and 6) zero moisture absorption.

A highly crystalline condition can be induced in parts made of the resin by special heat treating techniques (not revealed).

The improved resin is expected to be molded into valve seats, diaphragms, o-rings, gaskets and other parts for use in missiles, rockets, and electrical and electronic devices.

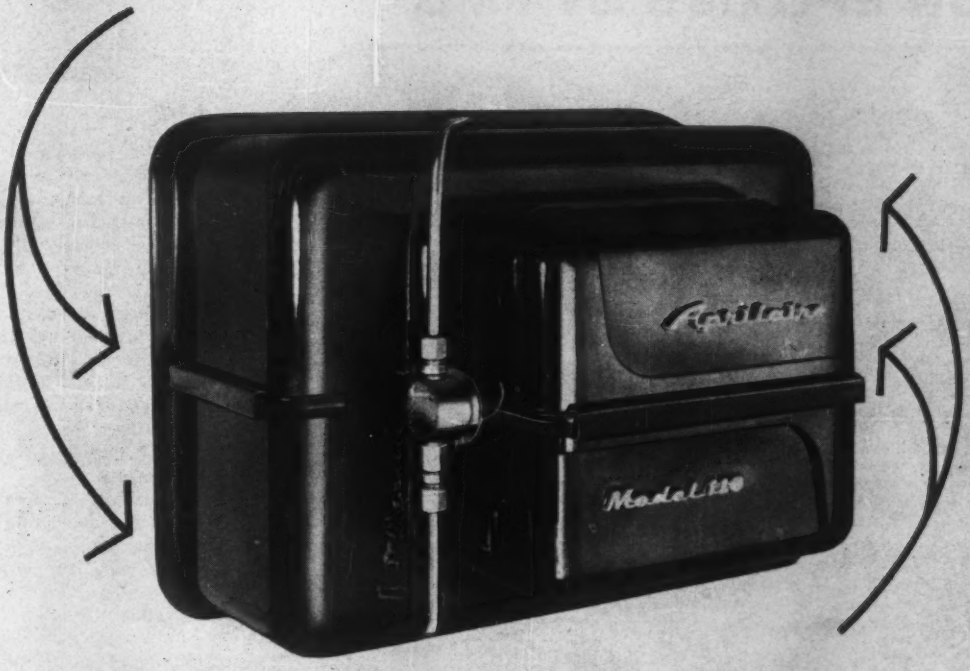
KEY NO. 618

Treated Steel Saves Annealing Time, Costs

Better and less costly annealed stainless steel parts have resulted from a new process developed by the Boeing Co., Seattle 24, Wash. The method consists of applying a very thin coating of silicone fluid to stainless steel prior to heat treating.

Metal loss is low

Total metal loss during one heat treatment and descaling operation is kept down to 0.1 to 0.2 mil per surface; metal loss for three annealings is held to 0.4 to 0.6 mil. Without silicone protection, the scale formed during heat treatment is so heavy that from 0.5 to 1.5 mils of



Humidifier CMPC-molded for lifetime service

The Aprilaire® high-capacity furnace humidifier will never have a problem from heat, rust or corrosive impurities of water. Manufactured by Research Products Corporation, it's housing is of CMPC-molded special-purpose phenolic . . . designed to permit easy accessibility for inspection and maintenance if necessary. The motor housing, drain pan and distributing pan are all integral molded-in parts of the neat, compact main housing. A bonus feature is soundproofing—helping make the unit whispering quiet.

To improve your products, or to meet one of those "difficult" manufacturing situations where a plastic is the answer—see your Chicago Molded Engineer . . . He'll have the solution for you!

Send for new brochure "Design and Purchase of Custom Molded Plastics".

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 F North Kolmar Avenue
Chicago 51, Illinois

For more information, turn to Reader Service card, circle No. 391

A CONDENSED FACT FILE ON EPOXIES BY FMC

OXIRON EPOXY RESINS 2000, 2001, 2002

These epoxidized polyolefins have multiple epoxy and reactive double bonds as reaction sites—Versatile cure thanks to greater reactivity—Lower density means more volume per pound—Uses include reinforced plastics, adhesives, surface coatings, potting, encapsulating, propellant binder—For the full story send for:

Epoxy Data Booklet

DIEPOXIDES

Dicyclopentadiene Dioxide

This difunctional epoxide can be used both as a modifier for conventional epoxy resins and as a primary building block for epoxy resins—Provides resins with high heat distortion points—Formulations are liquid and have good pot life.

Technical Bulletin No. 95

Limonene Dioxide

A colorless liquid combining the reactivity of an internal and an external epoxy group in the same molecule. Reactive diluent, pleasant odor and ease of handling are characteristics—Resin former itself.

Technical Bulletin No. 96

OLEFIN OXIDES

Octylene Oxide

Reactive diluent for epoxy resins—Improves low temperature flexibility of bisphenol A-based epoxy resins—Controls exotherm—Copolymerization to give unique polyols for polyurethane manufacture—Pleasant odor, safe handling.

Technical Bulletin No. 71

Dodecene Oxide

Versatile epoxide—Can be used as reactive diluent for epoxy resins to improve low temperature flexibility, intermediate in perfumes, plasticizer, stabilizer for chlorinated products, lubricant additive—Safe handling.

Technical Bulletin No. 73

C16-C18 Olefin Oxide

Mixed epoxidized olefin combining long chain hydrocarbon structure with a reactive epoxy group, stabilizer for chlorinated products.

Technical Bulletin No. 74

ALSO TERPENE OXIDES

Limonene Monoxide

Technical Bulletin No. 81

Alpha-Pinene Oxide

Technical Bulletin No. 82

For additional information on these products write for the bulletins mentioned above —

EPOXY DEPARTMENT, FMC CORPORATION

161 East 42nd Street, New York 17, N. Y.

For more information, turn to Reader Service card, circle No. 414

What's new IN MATERIALS

metal per surface are lost during each annealing and descaling cycle.

The cost of annealing and pickling silicone-treated stainless steel is said to be considerably less than that for untreated steel. Reason: metal loss is considerably reduced, milder acids are used, and less time is required for pickling. The developer says a faster pickling operation reduces the chance for intergranular attack on certain stainless steel alloys.

Other advantages given for the new process are:

1. No carbon pick-up or other adverse surface effects on the metal.
2. Parts usually need not be cleaned before coating and do not require clean glove handling as do most stainless steel alloys.
3. Application technique and process control are not critical.
4. No increase in annealing and pickling facilities is required.

KEY NO. 619

Acrylic Compound Has High Impact Strength

A new grade of high impact acrylic has been added to a line of molding compounds available from Rohm & Haas Co., Washington Sq., Philadelphia 5. Called Implex R, the molded compound has an impact strength (Izod, notched) of 4.5 ft-lb per in. compared to 2.3 for the highest impact grade previously available from the company.

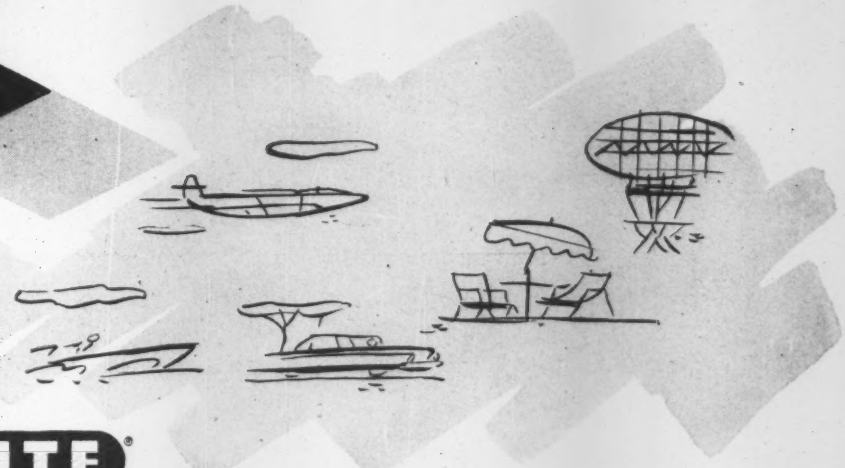
High transparency

The new grade is available in natural and in a wide range of standard

PROPERTIES OF IMPLEX R

Specific Gravity	1.08
Water Absorption (7 days at 73 F), %	0.5
Mold Shrinkage, mil/in.	4-8
Flammability (ASTM D635), ipm	1.2
Heat Distortion Temperature, F	
At 66 Psi	196
At 264 Psi	183
Service Temperature, F	165-185
Tensile Strength, psi	5800
Flexural Strength, psi	8500
Compressive Strength, psi	8000
Impact Strength (Izod, notched), ft-lb/in.	
At 73 F	4.5
At −13 F	0.5
Rockwell Hardness	R99

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY



Only IRIDITE®

Process Engineered

Chromate Conversion Coatings

Give you 5 additional benefits for Corrosion Protection—Paint Base—Decorative Finishing

1 A COMPLETE PROCESS ENGINEERED LINE

Developed for specific applications, there is an Iridite to provide the finish you desire, fit the equipment you have available and give the performance you require. Most Iridite coatings meet rigid military and civilian specifications.

2 EXPERIENCED TECHNICAL SERVICE

Our large field engineering staff is thoroughly familiar with chromate conversion coatings and related finishing operations. They'll help you check every step in your finishing operation to make sure you're getting the best possible finish on your products.

3 PRODUCT AVAILABILITY

Warehouses located in strategic industrial areas enable us to provide you with fast, economical delivery on any Iridite.

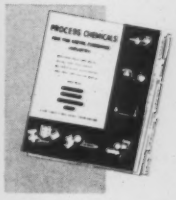
4 ECONOMY

The superior performance of Iridite provides low final cost by extending operating life and lowering maintenance costs. In addition, Iridite gives you a finish that adds considerably to the value of your product. There's an Iridite to meet every cost and performance requirement.

5 RESEARCH AND DEVELOPMENT FACILITIES

If you have an unusual application, we will gladly work with you. Our entire staff of experienced engineers and chemists, and our completely equipped facilities are at your service.

IRIDITE—a specialized line of chromate conversion coatings for non-ferrous metals. Apply by dip, brush or spray methods — at room temperature — manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. No special equipment, exhaust systems or specially trained personnel required.



If you are using chromate conversion coatings to finish zinc, cadmium, aluminum, magnesium, silver, copper, brass or bronze — consider the above benefits of Iridite. For complete information, contact your Allied Field Engineer. He's listed under "Plating Supplies" in the yellow pages. Or, write for FREE TECHNICAL DATA FILE.

Allied Research Products, Inc.

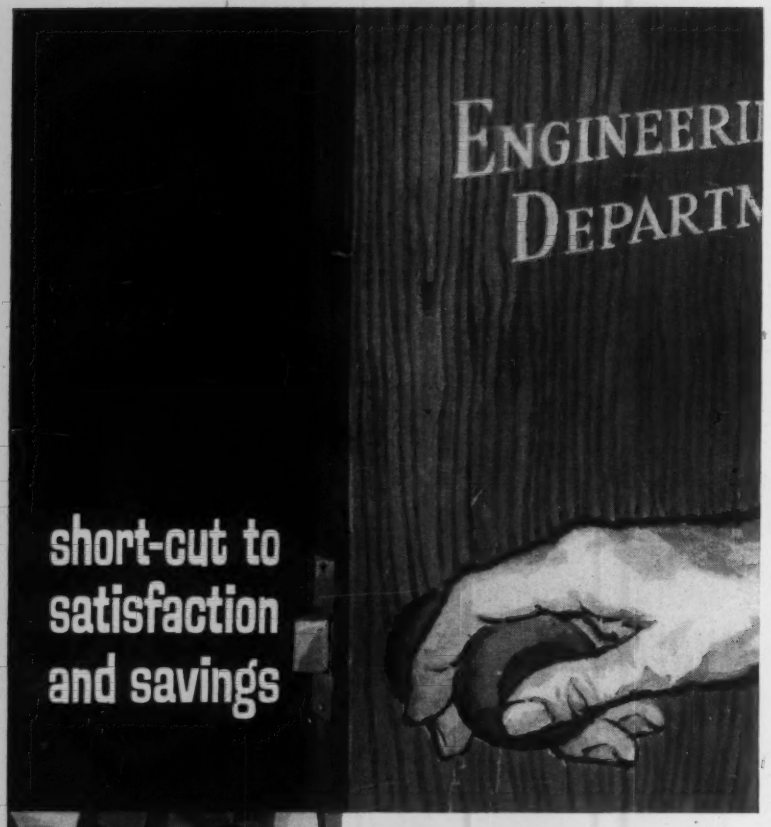
4004-06 EAST MONUMENT STREET • BALTIMORE 5, MARYLAND
BRANCH PLANT: 400 MIDLAND AVENUE • DETROIT 3, MICHIGAN

West Coast Licensee for Process Chemicals: L. H. Butcher Co. • European Agent: Stora Granberger, Storgatan 10, Stockholm, Sweden

Chemical and Electro chemical Processes, Anodes, Rectifiers, Equipment and Supplies for Metal Finishing

IRIDITE® Chromates | IRILAC® Coatings | ISOBRITE® Brighteners | ARP® Supplies | WAGNER Equipment

For more information, turn to Reader Service card, circle No. 428



Rolled Steel Rings of simple or complex cross-section can be produced by the Edgewater process, in diameters from 5 to 145 inches. Materials include carbon steel, stainless and heat-resisting alloys, tool steel.

Edgewater's first step in answering an inquiry for rolled steel rings is to have Engineering check the proposed design for possible modifications that would improve the ring and/or reduce the price. This assures a good design—one that meets all requirements, at lowest cost.

Forged from solid blocks of steel and rolled on a powerful ring mill, Edgewater weldless rings are formed to cross-section shapes so close to finished dimensions that very little machining is needed. Close tolerances mean less labor, less scrap loss, lower overall costs. The Edgewater rolling process assures maximum strength, toughness and uniformity. Send drawings for recommendations and prices.

INTERESTING description of the ring-rolling process is given in this brochure, **Edgewater Rolled Steel Rings.** We will be glad to send you a copy.

Edgewater Steel Company

P.O. Box 478 • Pittsburgh 30, Penna.

For more information, turn to Reader Service card, circle No. 402

What's new IN MATERIALS

colors. The material has a high degree of transparency in natural color; for example, molded parts with wall thicknesses of ⅛ in. or less are transparent enough to allow observation of liquid or powder levels in molded containers.

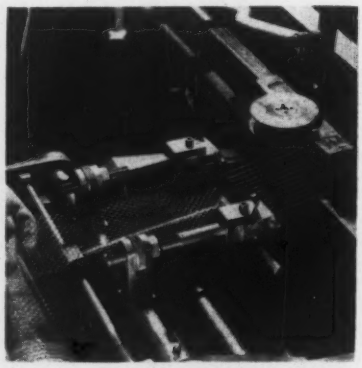
Typical applications include housing and control knobs for business machines, electrical appliances, portable radios and laboratory equipment; automobile armrests; telephone communication parts; toys; housewares; and photographic equipment.

The moldings are dimensionally stable, low in water absorption, resistant to staining and attack by many chemicals, odorless and tasteless. The compound contains no plasticizers.

Molded parts can be cut, drilled, machined and solvent cemented. Surfaces can be decorated by spray painting, engraving, printing, hot stamping, silk screening and vacuum metalizing. **KEY NO. 620**

Narrow Wire Cloth Is Less Costly

Lower cost wire cloth in narrow widths is being produced on new high speed ribbon looms developed by Reynolds Div. of National-Standard Co., Dixon, Ill. Widths range from ¾ to 8 in. in meshes 4 through 80. Previously, cost of narrow-width wire cloth was prohibitive because wide production looms had to be used



***Producing** wire cloth on a new narrow-width loom installed at Reynolds Div. of National-Standard Co.*

For more information, circle No. 383 ➤

10 second expert

Trouble free operation of this Polaroid Land Camera is the result of improved materials engineering, made possible by the high strength and corrosion resistance properties of this stainless steel powder metal part (a lens board locking lever.)

A powder metal parts fabricator can help you to improve your materials engineering—resulting in better equipment performance, with production economies.

Hoeganaes sells sponge iron and high alloy powders to the powder metal parts fabricating industry—a precision industry that should be working for you. Contact your nearest powder metal parts fabricator. He will deliver promised results.

The locking lever on the Polaroid Land Camera was manufactured by Dixon Sintaloy, Inc., Stamford, Conn. and used in Models 850 and 900.

HSIC

HOEGANAES SPONGE IRON CORPORATION

RIVERTON, NEW JERSEY

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Because of the great demand for the well-known Manuals and Special Reports that are widely used for reference purposes, MATERIALS IN DESIGN ENGINEERING has reprinted them for your use. These outstanding articles provide you with complete and useful information on the properties, characteristics and uses of engineering materials and finishes.

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....Low Cost Coatings for Metal Parts
....Why Metals Break; What to Do About It
....Appliances: What Materials Are Next?
....High Temperature Metals
....How Radiation Affects Materials
....Filament-Wound Reinforced Plastics
....Ferrous Castings
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....High Temperature Coatings for Metals
....Columbium

....The Challenge of the Materials Age—PRICE $1.00
....New Directions in Materials Testing—PRICE 75¢
....Guide to Materials Standards & Specifications—PRICE 75¢

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City.....Zone.....State.....

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Foreign subscriptions—$5.50.

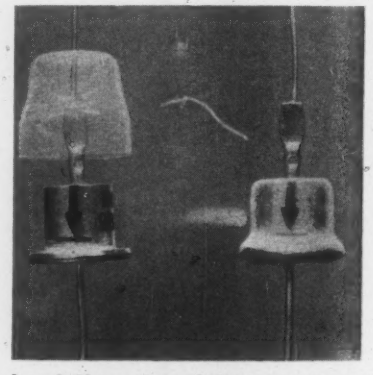
to make it, says the producer.

The new narrow-width wire cloth can be made to specifications from brass, copper, bronze, steel and stainless steel. It can be painted, hot-dip galvanized, electrogalvanized and tinned. KEY NO. 621

Nylon Resin Used for Coating Wire, Cable

A new general purpose nylon resin has been designed primarily for extrusion coating wire and cable. Known as Zytel 53, the resin is available from E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

The resin is transparent, has excellent stability and good weatherability, and is more flexible than former compositions. Weatherometer tests show that Zytel 53 has twice the weatherability of natural colored



Insulating transistor cases — Diode and transistor cases can be insulated in a few seconds by using a new heat shrinkable sleeving called Thermofit. Marketed by Rayclad Tubes Inc., Redwood City, Calif., the sleeving is preformed to fit standard case sizes of semiconductor devices. It is sold in several plastics materials, including a modified TFE compound and an irradiated polyolefin compound.

The producer says the sleeving can be slipped easily into position over the case and then permanently locked into place by heating the lower part of the preform, thus causing it to quickly shrink and form a skintight encapsulation.

KEY NO. 623

"Black CRYSTOLON*" grain

...crystals that master lightning

Often referred to as "Black CRYSTOLON", Norton E 179 CRYSTOLON Electrical Grade silicon carbide grain is widely used in lightning arrestors — and in a steadily increasing variety of other nonlinear resistor applications in the electrical-electronics field.

These applications include protection of coils from overvoltage, protection of relay contacts, and general voltage stabilization . . . with voltage or surge control requirements ranging from thousands of amps to microamps . . . in resistors ranging in volume from thick arrestor blocks to paper-thin varistors.

To control its semiconduction properties, E 179 differs from regular CRYSTOLON silicon carbide grain by the addition of alumina. But the most important control of E 179 is constant control through each step of manufacture, from electric furnace to shipping drum. Accurate, duplicable grain impedance (resistivity) is assured by careful furnacing, grain processing, sizing, blending and surge testing.

In loose pack or ceramic bonded form, E 179 CRYSTOLON grain has the nonlinear current-voltage relation $I = AE^n$, where "A" and "n" are constants. For loose grain "n" may be as high as 10; for bonded grain it is usually between 3 and 7.

For surge tests, standard 280 ampere pulses are passed through a column of compressed E 179 CRYSTOLON grain, 1" diameter x 1" long. Voltage across the cell is measured in kilovolts per inch. E 179 CRYSTOLON grain is available in sizes of 60 to 240 mesh, covering a surge test range of 1.6 to 13.0 KV/inch.

For further facts, contact NORTON COMPANY, Refractories Division, 351 New Bond Street, Worcester, Mass.

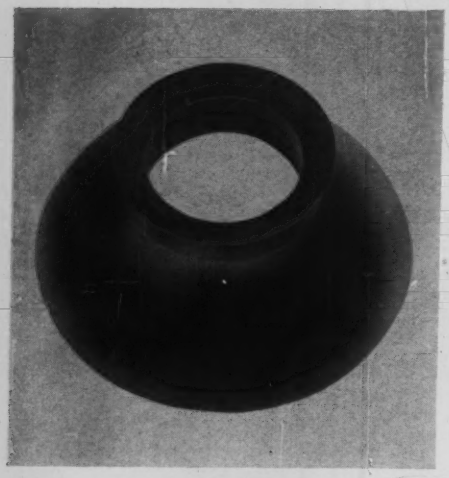
*Trade Mark Reg. U. S. Pat. Off. and Foreign Countries.

NORTON
REFRACTORIES
Crystallizing ideas into products

For more information, turn to Reader Service card, circle No. 329

ElastaCAST®

SOLVES CRITICAL MATERIAL SELECTION PROBLEMS



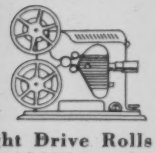
Automotive Ball Joint Seal. *"30,000 miles without ball joint lubrication" resulted from Ford Motor Company's use of oil-resistant ElastaCAST for ball joint seals in its 1961 Fords, Mercurys and Lincoln-Continentals. This application takes advantage of ElastaCAST's abrasion resistance, tear strength, excellent weathering properties and low permanent set.*

If you are planning a product that requires a material with unusual properties, take a look at ElastaCAST. Let us work closely with you, particularly in your early design work; experience has shown us that definite savings in design, production and the finished part generally result.

ElastaCAST is a new liquid polyurethane elastomer possessing an unusual range of mechanical and physical properties — such as outstanding abrasion, tear and ozone resistance, oil and gas resistance and high load-bearing. Here's a whole new sales advantage made possible through our rubber and plastics technology. Call us about your tough or unusual applications.

ACUSHNET PROCESS COMPANY
760 Belleville Avenue, New Bedford, Mass.

Acushnet



Light Drive Rolls *of ElastaCAST assure longer life... higher drive friction.*

Shoe Toplifts *of ElastaCAST outwear nylon, rubber or leather . . . take impact bearing loads up to 7,000 psi.*

Textile equipment bearings *of ElastaCAST outlast metal as well as conventional rubbers and plastics.*

Please send my copy of your new 16-page ElastaCAST Design Manual.

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

For more information, turn to Reader Service card, circle No. 371

nylon resins, suggesting its use in applications where transparency and resistance to occasional sunlight are requirements, such as jacketing over color-coded primary insulation.

Some typical uses for Zytel 53 resin are extrusion coatings on hook-up wire, control cable, gasoline station wire, electric blanket wire, building wire, radiant heating wire and automotive ignition wire.

KEY NO. 622

Tungsten Carbide Rod Coats Large Parts

A new rod for electric arc application of tungsten carbide has been introduced by Kennametal Inc., Latrobe, Pa. Called KT-200, the rod is particularly recommended for hardfacing large parts.

The arc rod consists of a solid tungsten carbide core surrounded by a steel sheath; a coating on the rod permits the deposition of a hard surface that is said to be as smooth as surfaces applied by a mild steel welding rod. The deposit flows on parts easily and has extremely low porosity and a minimum of heat checking, according to the producer.

Suitable for either bead or wash pass application, the rod can be used with either a.c. or d.c. reverse polarity current. Rockwell hardness of deposits ranges from C58 to C63 for a single pass, from C60 to C65 for a double pass.

The rods are 3/16 in. in dia and 14 in. long. Coverage at ⅛-in. thickness is 25 sq in. per lb of rod.

KEY NO. 624

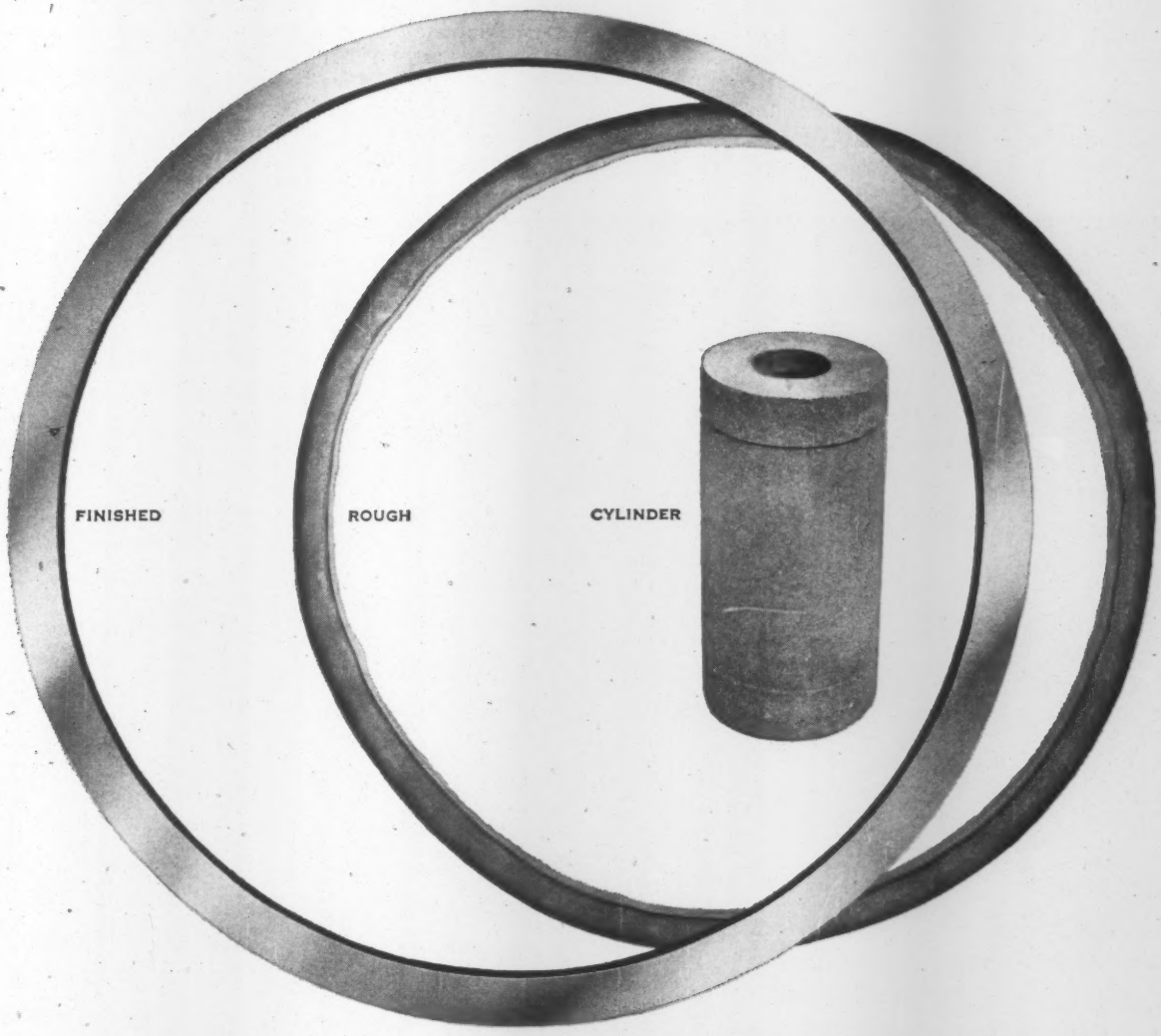
Composite Crystals for Maser Applications

Composite crystals with a synthetic ruby core and a synthetic sapphire sheath are now being grown on a production basis by the Crystal Products Dept. of Linde Co., Div. of Union Carbide Corp., 4120 Kennedy Ave., East Chicago, Ind.

Chromium ions which produce both the maser action and the red ruby color in the material are confined to the center of the ruby crys-

NOW—A WELD-FREE CM-R 41 RING DEVELOPED BY C-M TO ELIMINATE THE PROBLEMS OF WELDED RINGS.

THIS CM-R 41 RING IS FORGED FROM A CYLINDRICAL CASTING INSTEAD OF ROLLED FROM BAR STOCK AND WELDED. THIS INTEGRAL, WELD-FREE CM-R 41 RING IS THE RESULT OF A CASTING PROCESS DEVELOPED BY C-M USING A THIN CROSS-SECTION RATHER THAN THE CONVENTIONAL THICK INGOT. BECAUSE THE CROSS-SECTION IS THINNER, IT COOLS QUICKER. THIS FAST COOLING PREVENTS SEGREGATION OF ELEMENTS—ELIMINATES STRINGERS. GRAIN SIZE IS MORE UNIFORM, TOO, AND THE RING HAS GREATER HOMOGENEITY THAN RINGS PRODUCED BY OTHER METHODS.



C-M'S PROCESS CAN HELP SOLVE YOUR RING PROBLEMS ON CM-R 41 AND OTHER DIFFICULT-TO-FORGE IRON, NICKEL AND COBALT ALLOYS. WRITE TODAY FOR COMPLETE INFORMATION.

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METALLURGICAL SPECIALISTS • 2873 LINCOLN STREET • MUSKEGON, MICHIGAN

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Made possible, made better, made for less

made with CHEM-O-SOL®

SCREENS and SPRINGS and "SPAGHETTI"

Chem-o-sol, the most adaptable plastic for coating, molding and gasketing, makes screening strong, long lasting, weather-resistant — and *practicable*. Colorful, too. Chem-o-sol is die-wiped on glass yarn or aluminum wire, at 600 feet per minute.

Auto seat springs shouldn't be seen — or *heard*. Chem-o-sol (flow-coated on springs at troublesome rub-spots) takes the squeak out. Here's how: special formulation for maximum flexibility, abrasion-resistance. Fast, easy, economical application.

Some electrical applications call for spaghetti tubing with extra resistance to abrasion, "cold flow" and heat. Reinforcement is vital; Chem-o-sol's liquidity makes it possible. Result: glass and vinyl can work together in a sleeving to beat problems neither could lick alone. Even defy heat up to 225°F.

and YOUR PRODUCT or IDEA-FOR-A-NEW-PRODUCT

CHEMICAL PRODUCTS CORPORATION East Providence, Rhode Island

For more information, turn to Reader Service card, circle No. 439

HOW CHEM-O-SOL MAY HELP YOUR PRODUCT OR PRODUCT-IDEA

Tailor-made for you! We have a world of experience in specialized formulation, plus the industry's most complete laboratory.

Color? You name it! Chem-o-sol has done wonderful things with color. If c 'or is one of your problems, just ask us to *prove* that we can reproduce your most difficult shades and tones — precisely, in quantity production, without annoying variation.

Processing? Just heat it! Dipping, molding, casting, spreader-coating, foaming, wiping, spraying, printing, pressure-forming . . . Chem-o-sol is the all-process plastic. Formulated as a liquid without volatile components, it changes to a strong, resilient solid — simply by heating to about 350°F., without pressure.

Versatile! More than a coating, molding or gasketing compound, Chem-o-sol is a new basic material that has widened the useful horizon for vinyls. From coatings for cosmetic containers to joints for sewer pipe, Chem-o-sol is the practical, practicable answer. Can it help *you* — cut production time and cost, make a *better* product, create a *new* product?

Adaptable! Just for example . . . *Tensile strength:* up to 2700 psi. *Elongation:* 150% to 600%. *Hardness:* Shore A2 as required from 10 to 100, Shore D up to 65. *Flexibility:* to withstand temperatures as low as minus 65°F. *Chemical resistance:* impervious to most acids, alkalies, detergents, oils, and some solvents. *Heat resistance:* to 225°F. for as long as 2,000 hrs.; to 450° for two hours and more. *Dielectric strength:* minimum 400 volts per mil when fused in sections 3 mils thick. *Solids content:* 100%. Can be molded in very thick sections. *Viscosity:* meets all requirements for widest range of application-processes.

FREE HELP

Yours for the asking: Fact-filled Chem-o-sol brochure. Send to:

CHEMICAL PRODUCTS CORPORATION
Dept. M12, King Philip Road
East Providence, R. I.

Name .....
Title .....
Company .....
City ..... Zone ..... State .....

tal. According to Linde, this arrangement takes advantage of the high refractive index (1.76) of the crystal to focus pumping light where it is needed. Thus the concentration of light necessary to induce maser action can be obtained by using less total pumping light.

Crystals are 1 in. long

The composite crystals are about 1/10 in. in dia by 1 in. long, and have a final internal chromic oxide concentration of 0.05% by weight. Crystals double this diameter and length may be available at a later date.

An optical maser operates on the principle of stimulating the excited atoms in a material to radiate in phase. A flash lamp provides the pumping power and when flashed causes a nearly parallel beam of light to emerge from the material. This light is highly monochronomatic and coherent, having a definite phase relationship from point to point in all parts of the beam. The light beam emerges from the maser in an extremely narrow cone.

KEY NO. 625

Fluoroelastomer Parts Are Oil, Heat Resistant

Sheets, tubing, gaskets and custom-molded products made of a new fluoroelastomer compound called Fluran F-5000 can be used over the temperature range –40 to 600 F. The parts are available from U. S. Stoneware Co., Plastics & Synthetics Div., Akron 9, Ohio.

According to the developer, Fluran F-5000 has good resistance to oils, fuels, lubricants, most mineral acids, and may aliphatic and aromatic hydrocarbons, such as carbon tetrachloride, toluene, benzene and xylene. It is not suitable for use in low molecular weight esters and ethers, ketones, certain amines, hot anhydrous hydrofluoric or chlorosulfonic acids, or some proprietary fluids

GRC tiny die castings made in one fast automatic operation ...simple or intricate parts, high in quality, low in cost

Gries' exclusive patented methods make possible wide design latitude . . . assure uniformity, accuracy and smooth surfaces on small parts of all types . . . for a wide variety of uses . . . at substantial savings. GRC die castings leave the machines trimmed, ready for use. In addition GRC's unique single cavity die casting techniques offer new shortcuts in assembly . . . new approaches in product design through our exclusive methods.

tiny zinc die castings

NO SIZE TOO SMALL! Maximum sizes up to 2", ½ oz.

Write for samples, prices & fact-filled booklet "Small Zinc Alloy Die Castings," Includes helpful designer's check list.

25 years of progress in tiny parts

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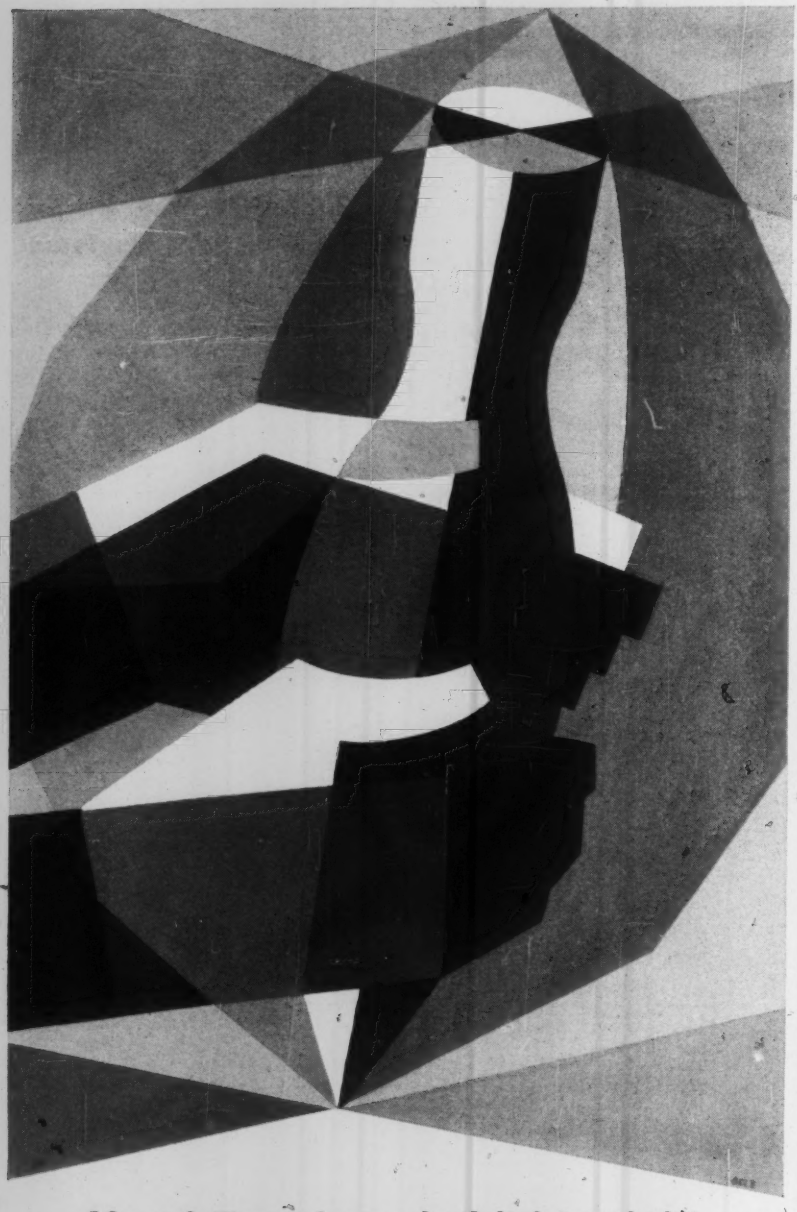

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61-T-6

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such as Skydrol 500.

The material is supplied in Shore A Durometer hardnesses from 60 to 95. At present, black is the only color available. KEY NO. 626

PROPERTIES OF FLURAN F-5000

Tensile Strength, psi	
Room Temperature	2000-3000
300 F	300-1000
Elongation, %	
Room Temperature	100-400
300 F	80-200
Dielectric Strength, v/mil	500
Volume Resistivity, ohm-cm	1.4×10^{14}

Alloy Flux Rebuilds Manganese Steel Parts

A new agglomerated alloy flux for submerged arc welding and rebuilding of 12-15% manganese steel parts has been developed by Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17.

The flux, called Lincolnweld M-210, is said to offer economies in surfacing and rebuilding manganese steel parts by reducing materials costs and increasing deposition rates and welding speeds.

Typical applications include joining premium-priced manganese steel castings to low cost carbon steel framework, and reclaiming worn carbon or manganese steel surfaces.

Properties of weld metal deposits are: yield strength, 64,000 psi; tensile strength, 108,000 psi; and elongation (in 2 in.), 35%. As-welded deposits have a Rockwell hardness of C11 to C19 and can be machined. After work hardening, the deposit develops a surface hardness of Rockwell C48 to C53.

A typical deposition rate is 16 lb of weld metal per hr. The deposit is said to be less subject to carbide precipitation during cooling than high alloy manganese steel. KEY NO. 627

Epoxy-Saturated Cord for Holding Uses

A new epoxy-impregnated glass cord for electrical lashing and holding applications has been announced

A full-length coat of light-colored mutation mink requires about 65 pelts, and may carry a price tag as high as $10,000. Individual pelts may be worth as much as $100.

Bethanized steel wire protects her $100 coat

Several years ago, Victor Peternel, a mink rancher in Meadowlands, Pa., was troubled by a costly problem. Rust stains from wire cages downgraded the valuable pelts of his light-color minks, often cutting their sale price in half. Also, he replaced the pens constantly, because ordinary galvanized wire didn't resist the abrasive action of the animals' feet and the harsh corrosion caused by their body acid.

Mr. Peternel, who makes mink cages for his own use and supplies mink wire to other ranchers, consulted with a manufacturer of welded steel wire fabric. They decided to try Bethlehem's bethanized wire, with an extra heavy, C coating of 99.9 per cent pure zinc. After several years the trial cages showed not one spot of rust.

Bethanizing Gives Heavier Coating Weights Than Hot-Dip Galvanizing

Bethanizing, our electrolytic zinc-coating process, makes possible a wide range of coating weights. Including the C coating, four standard weights are available: A; B, twice the A coating; the C coating, three times A; and D, four times the A weight.

Bethanizing also assures complete uniformity, tight bond, high ductility, and ability to withstand severe forming. For more information, get in touch with the nearest Bethlehem office. Or write to us in Bethlehem, Pa.

Here, in one of our customers' plants, is where Bethlehem's bethanized (C coating) wire is made into welded-fabric. It is spooled in 100-ft rolls for such applications as mink cages and chicken pens.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

Steel *for Strength ... Economy ... Versatility*

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BETHLEHEM STEEL

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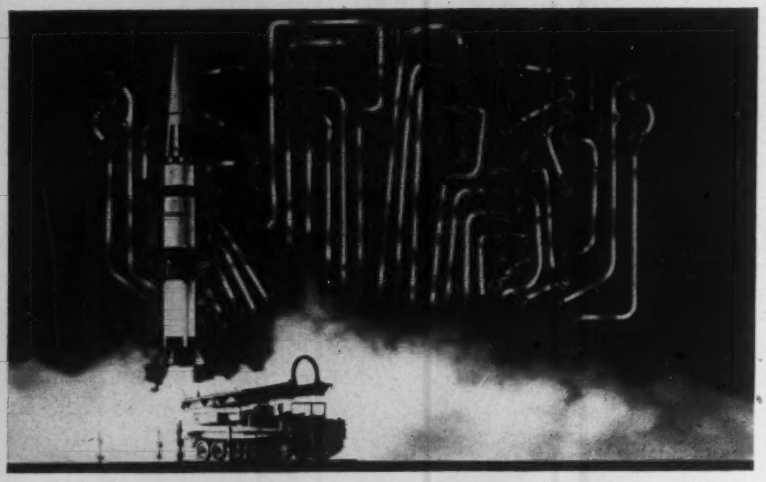

AUTRONEX ACID GOLD* MEETS PERSHING MISSILE SPECS

Dev Tek, Inc., Orlando, Florida, uses the patented Autronex Acid Gold Process to plate circuit conductors, as applied to the new Pershing Missile. According to Mr. A. F. Goldsby, Dev Tek President, Autronex Acid Gold affords easy compliance with the rigid ABMA-428 specifications for a hard, bright coating of gold alloy 100-150 millionths thick covering all circuit conductors. Pershing Missile component-finishing specifications are acknowledged to be among the most exacting. Whenever tough specifications are to be met, whenever the unique properties of precious metals are required *without the shortcomings of conventional electroplate*, missile, electronics manufacturers and government agencies specify Sel-Rex. Technical literature free on request. Specify precious metal and your application.

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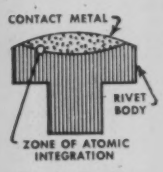
For more information, turn to Reader Service card, circle No. 350

Gibson Atomiclad* Electrical Contact Rivets now available in economical Gibson Assemblies

ATOMICLAD RIVETS ARE LOWER COST BECAUSE IT COSTS LESS TO MAKE THEM



Patents Pending

And they're BETTER because their bond of dispersed atoms of the precious contact metal and the base metal of the body is electrically and mechanically superior to other bonding methods. Cost is further reduced by limiting use of precious metal to electrical requirements of the contact.

Atomiclad Rivets are made in all standard forms and of copper, steel or other base metal with contact face of precious or semi-precious metals.

Many sizes and types are stocked in quantity. Write for Standard Stock List #2007, and for Technical Information Bulletin 400.

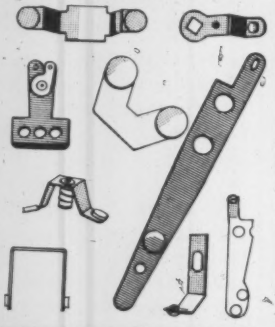
ECONOMICAL GIBSON CONTACT ASSEMBLIES

Gibson contact support manufacturing facilities include every phase—forming, riveting, heat-treatment and electroplating and comprises use of any specified metal.

When you specify Gibson Contact Assemblies, you get the benefit of years of engineering know-how in providing the best possible electrical union between contact and support member. Since all assemblies are Gibson-inspected, the customer suffers no loss through assembly rejects.

Gibson Engineers will design your complete contact assembly upon receipt of specifications. Or send your drawings for fabrication costs. If you prefer your own support member, send a sample for assembly cost.

*ATOMICLAD—Trademark Gibson Electric Company



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Gibsiloy ELECTRICAL CONTACTS Since 1933

For more information, turn to Reader Service card, circle No. 335

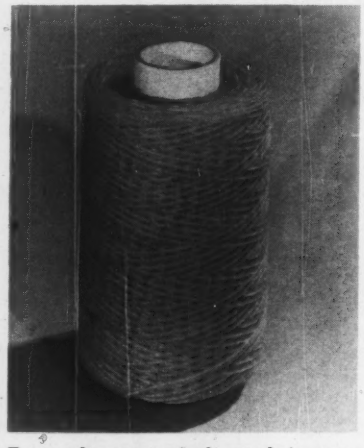
by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Called Scotchply XP-205, the cord is saturated with an uncured high temperature epoxy resin; the resin prevents glass abrasion and weakening during handling.

Currently used as a string band on large commutators, the epoxy-impregnated cord is wrapped on the commutator with a tension of 20 to 30 psi, overcoated with a thin layer of epoxy resin, then cured. The additional coating of resin gives a smooth surface that does not collect dirt, carbon, grease and other foreign matter.

Some potential uses are miscellaneous holding and tying applications on motors, generators, transformers and large coils.

The coil is self-extinguishing and has a shelf life of three months at room temperature. Tensile strength after curing is 210 psi and arc resistance is 120 sec. **KEY NO. 628**

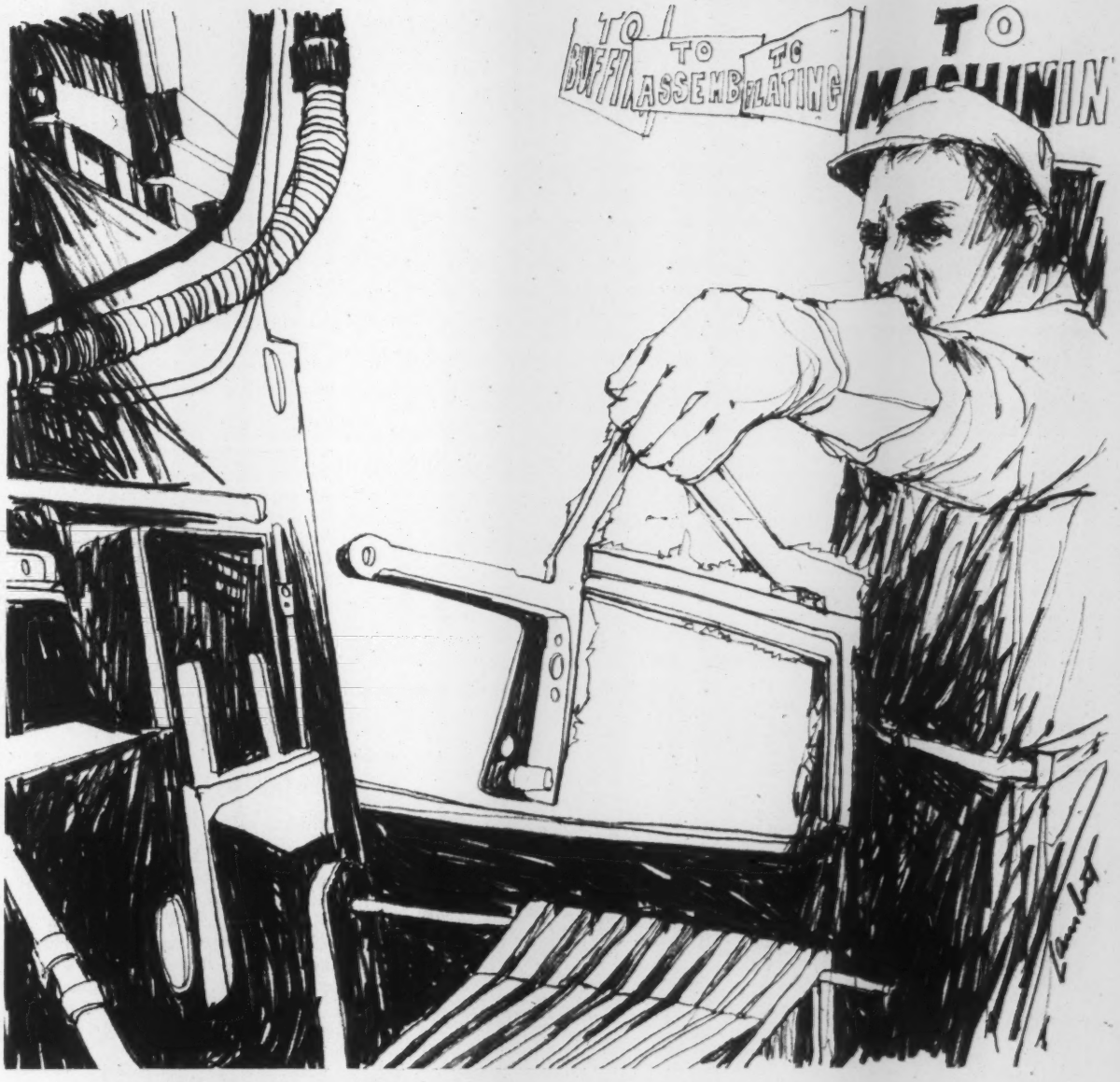


***Epoxy-impregnated cord** is supplied on a 1½-in. i.d. core.*

Four Tank Linings Resist Brine, Acids

Four new tank lining compounds are being marketed by Ceilcote Co., 4899 Ridge Rd., Cleveland 9. They are sold under the tradename Coroline.

No. 505 is a troweling compound based on a modified epoxy resin. Designed for use on chemical storage



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We're die casters, of course. Biggest, best-equipped, most service-minded in the business. More facilities, more highly experienced personnel, the widest range of die-castable alloys, our own fleet of trucks to give overnight rush service when needed. When you want a part die cast, you can't do better than Doehler-Jarvis. *But that's not all!* If you're a cost-conscious purchasing agent or production man, consider the other advantages of using Doehler-Jarvis. We'll not only die cast the part you want, but drill it, tap it, ream it, buff it, degrease it, finish it (plate it, paint it, anodize it, or whatever), sub-assemble it, inspect it, package it and ship it. To you or direct to your distributors. The plant is ours, but the production line—from blueprint to final packaging—is yours. Chances are we can save you money every step of the way. Ask Doehler-Jarvis to quote on your very next job. Call or write the Doehler-Jarvis office or plant nearest you.

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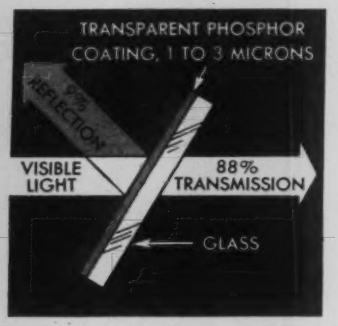

Excellent resolution capabilities for use in electronic projection applications

This vacuum-deposited coating developed by Liberty Mirror has a light output of 15 foot/lamberts or greater, at a power dissipation level of 25 milliwatts with peak output using a screen voltage up to 15 KV. It illuminates with extreme resolution.

Other vacuum-deposited coatings are used to make metallic first-surface mirrors, neutral filters, transparent mirrors, high-efficiency beam splitters, beam-splitting dichroic mirrors and filters. Metallic and transparent electrically conducting coatings are also available for resistance heating. Static-dissipating and high-frequency shielding coatings are also available.

Applied to glass, optical parts, metal, epoxy or plastic, the coatings are used in such varied products as toys, cameras, pin setters, wheel aligning equipment, aircraft and missiles. Liberty Mirror engineers will help you solve application problems. Technical data sheets are available on all coatings. Write L·O·F, Liberty Mirror Division, 23121 Libbey·Owens·Ford Building, Toledo 1, Ohio.

For more information, turn to Reader Service card, circle No. 390

In coils. Thicknesses from .020 to .070 in., widths of 2, 4, 6, 8 in. Ideal for punched parts under static or dynamic loads (gaskets, washers, closure liners, etc.).

See your nearest Hyde distributor or write for complete information.

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Established 1932
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Member Plastic Pioneers
DISTRIBUTORS FROM COAST TO COAST

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DELRIN* 500 ROD · SLAB · STRIP HEAVY-WALL TUBE
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ZYTEL* 31 LEXAN† polycarbonate IMPLEX** A ROD AND SLAB

*Du Pont trademark
†General Electric trademark
**Rohm & Haas trademark

For more information, turn to Reader Service card, circle No. 358

What's new IN MATERIALS

and processing equipment, the compound contains a silica filler, glass reinforcement, and an amine-type hardening agent. Maximum service temperature is 180 to 200 F.

No. 510 is an epoxy-base compound containing glass reinforcement and a carbon filler. It is used as a lining on steel and concrete tanks. Service temperature: 180 to 220 F.

No. 525 is made of an undisclosed thermosetting plastic reinforced with fiberglass. The coating is recommended for use on steel tanks and process equipment exposed to dilute chemicals, distilled and deionized water, chemical wastes, sewage, foods and salt brines.

No. 530 is a troweling compound containing an undisclosed plastics resin, a plasticizing hardener and a silica filler. The compound has good resistance to thermal shock. It is designed for use on steel and concrete tanks. **KEY NO. 629**

Polyethylenes Have High Specific Gravities

Three new Type III higher density polyethylene resins have been introduced by Hercules Powder Co., 910 Market St., Wilmington 99, Del.

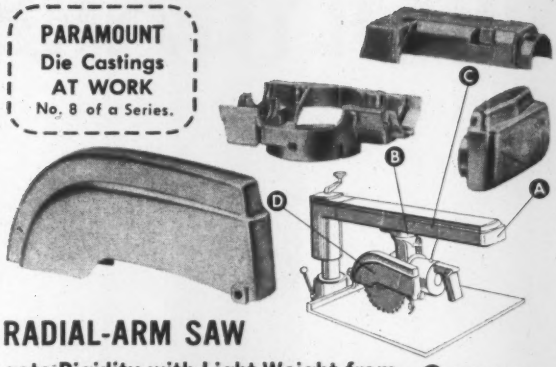
Compared to conventional higher density polyethylene resins, the new grades have 1) higher specific gravities, 2) higher hardnesses, 3) higher heat distortion temperatures, and 4) greater stiffness. They are made with new Ziegler catalyst recipes. Price: 32¢ per lb in carload lots.

Potential uses include beverage cases, molded seats for institutional

PROPERTIES OF HI-FAX RESINS

Grade →	2000	2100	2200
Melt Index, gm/10 min	8.9	4.5	3.5
Specific Gravity	0.964	0.962	0.062
Ht Dist Temp, F			
At 66 Psi	189	185	183
At 264 Psi	127	127	126
Rockwell Hardness	R66	R64	R65
Impact Str, (Izod, notched), ft-lb/in.	0.8	1.8	2.8
Tensile Strength, psi	3200	3300	3100
Stiffness in Flexure (74 F), 1000 psi	129	137	141
Stress Crack Res (Bell Labs), hr.	10	10	10

PARAMOUNT
Die Castings
AT WORK
No. 8 of a Series.



RADIAL-ARM SAW
gets Rigidity with Light Weight from
PARAMOUNT DIE CASTINGS

A TUBE CAP
B LOWER CARRIAGE SLIDE
C UPPER CARRIAGE SLIDE
D BLADE GUARD

Central Specialty Division, King-Seeley Thermos Company, selected Paramount to supply the die castings for critical parts of this high quality Craftsman saw, made exclusively for Sears, Roebuck and Co. Why Paramount? Because of Paramount's well-known engineering and production know-how—Paramount's ability to consistently meet the highest standards of precision at lowest possible cost—Paramount's careful scheduling which assures deliveries that fit customers' production schedules.

It will pay you to look to PARAMOUNT . . .

If your product incorporates zinc or aluminum die castings, or you're considering them, investigate Paramount's **complete** services—from drawing board to finished part.

PARAMOUNT *Die Casting Co.*
(A subsidiary of TALON, INC.) ST. JOSEPH 5, MICHIGAN
Three complete plants—two in St. Joseph, Mich., one in Seymour, Ind.

For more information, turn to Reader Service card, circle No. 346

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Perforating

—on all types of flexible materials, rigid sheets, and foam.

plastics
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in sheets and rolls up to 72" wide

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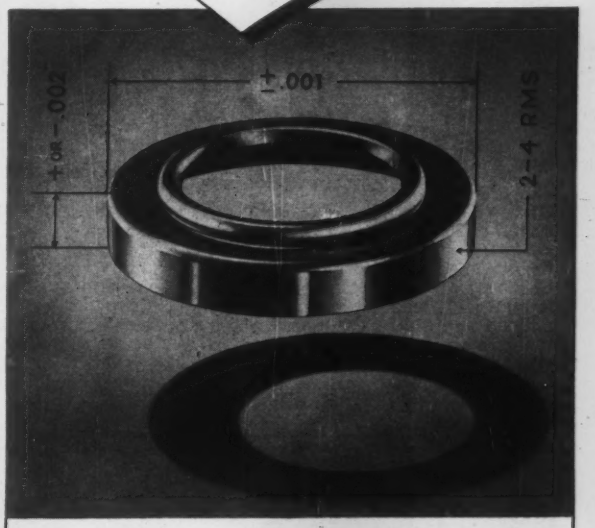

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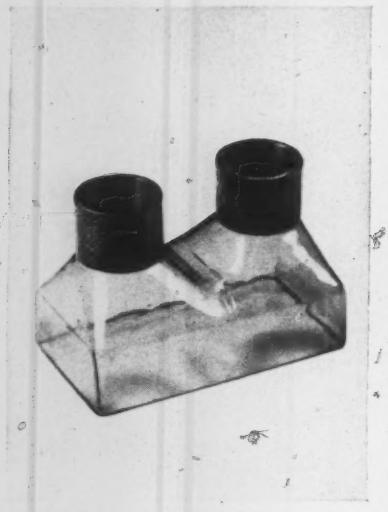
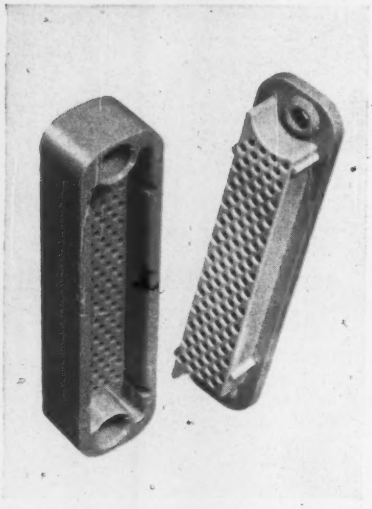
G-E LEXAN POLYCARB

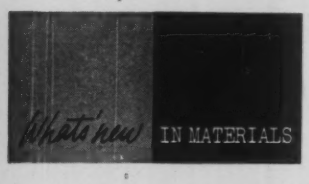
STRENGTH LEXAN slider for 4-pole switch is 20% glass-filled. The material withstands high impact forces and its flexural modulus is over 1 million psi. Used in rocket sled tests, the filled resin is relatively independent of heat, aging and most environments. It has high melt temperature and excellent electricals. (Atlas Chemical Industries)



IMPROVED FABRICATION. Formerly made of brass, blower couplings for radar unit are now inexpensively vacuum-formed of LEXAN resin, allowing considerable savings in machining costs. Couplings of polycarbonate resin are tough, flame-resistant, give smoother air flow than before. They withstand cycling from —54°C to +54°C under humid conditions. (General Electric)



GOOD ELECTRICALS. Microminiature connector contains up to 20% more contacts in the same space, thanks to dimensional stability and good electrical properties of LEXAN resin. Self-extinguishing, the material provides low loss, good insulation resistance and a dielectric constant and power factor which are virtually independent of temperature. (Amphenol-Borg Electronics Corp.)



furniture, automotive parts, housewares, large toys, and film and paper coatings. KEY NO. 630

Hi-Fax 2000 has a melt index of 8.9 and a specific gravity of 0.964. The resin is said to mold easily with no sacrifice in stiffness and hardness and with little loss in yield strength.

Hi-Fax 2100 has a melt index of 4.5; specific gravity, 0.962.

Hi-Fax 2200 has a melt index of 3.5; specific gravity, 0.962.

The new resins can be injection molded into parts that are adequately stiff in thin sections without becoming brittle or subject to flex cracking. KEY NO. 630

Other News . . .

Metals

▸ Wire cloth woven of A-286 chromium-nickel-titanium alloy has been introduced by National-Standard Co., Reynolds Div., Dixon, Ill. The cloth can be used at temperatures up to 1000 F. KEY NO. 631

▸ Cerium-coated molybdenum, nickel and Inconel strip measuring 1 by 0.005 by 9 in. is being marketed by Ronson Metals Corp., Cerium Metals and Alloys Div., 45-65 Manufacturer's Pl., Newark 5, N. J. The coated strip is recommended for use in electronic devices. KEY NO. 632

▸ A new line of thin-wall welded tubing is available in more than 80 grades of corrosion and heat resisting stainless steels, high temperature alloys, heat treatable low alloy steels and reactive metals. The tubing, sold by Carpenter Steel Co., 101 W. Bern St., Reading, Pa., is made in wall thicknesses from 0.005 to 0.125 in. KEY NO. 633

Plastics

▸ A general purpose epoxy plasticizer for vinyl is said to have excellent heat and light stabilization characteristics combined with excellent low temperature flexibility and good compatibility with vinyl resins. Called Flexol GPE, the material is available from Union Carbide Chemicals Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17. It sells for 33.75¢ per lb in carload lots. KEY NO. 634

▸ A new polyvinyl chloride packaging film is being produced by Borden Chemical Co., 1 Clark St., North Andover, Mass. The film, called Resinite VF-70, has excellent heat sealability and high clarity. It sells for 69¢ per lb. KEY NO. 635

▸ Delrin acetal strip for use in punched parts such as gaskets, washers and closure liners is available from A. L. Hyde Co., Grenloch, N. J. It is supplied in thicknesses from 0.020 in. to 0.070 in., and in widths from 2 to 8 in. KEY NO. 636

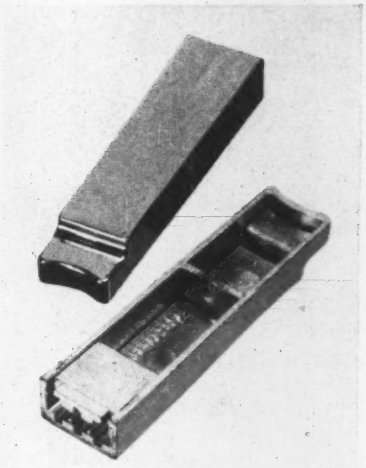
▸ A new conductive plastic (composition not disclosed) is expected to be used for printed circuits and other electronic parts. The material is available from Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 25. KEY NO. 637

Other nonmetallics

▸ Unsilvered ruby laser rods currently available from Trion Instruments, Inc., 1200 N. Main St., Ann Arbor, Mich. are said to be more relfable and durable than silvered rods. Configuration is a roof-top geometry polished into the rod with a 90-deg included angle forming a two-dimensional corner reflector. The output end is flat and parallel to the plane of the corner reflector. KEY NO. 638

▸ Six major plywood manufacturers have announced availability of fir

ONATE RESIN THE MOST VERSATILE OF THE TOUGH THERMOPLASTICS



HEAT RESISTANCE. Because LEXAN resin can be painted with wear resistant high-temperature bake finishes, it was chosen to replace zinc die castings for auto radio pushbuttons. Base and top coats of these vacuum-metalized parts are baked at 265°F. Buttons are economically injection molded and light in weight . . . make a tight fit on the metal stake. (Motorola, Inc.)

TRANSPARENCY. Face-glass of this pressure gauge is molded of LEXAN 102 — a new, virtually water-white grade of resin. The instrument uses a gray LEXAN back-plate. Transparent LEXAN resin is shock- and heat-resistant . . . replaces glass. The opaque plastic replaces steel or brass. The two injection molded shells form a strong, good looking case. (United States Gauge)

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plywood panels measuring 8 ft or more in width and in "any reasonable length." The companies are: Cascades Plywood Corp.; Diamond Lumber Co.; Georgia-Pacific Corp.; International Paper Co.; Simpson Timber Co.; and U. S. Plywood Corp. KEY NO. 639

▸ A TFE resin-impregnated asbestos packing material has been introduced by Garlock Inc., Palmyra, N. Y. Style 5881 is a TFE-impregnated blue asbestos designed for use with strong acids, caustics and other corrosive materials. Style 5875 is a white asbestos designed for use with edible liquids, gasoline and hot oils. Both styles can be used over the temperature range —90 to 500 F. KEY NO. 640

▸ An FEP fluorocarbon resin-coated glass fabric with excellent electrical properties has been added to a line of TFE resin-coated fabrics called Armalon and available from E. I. du Pont de Nemours & Co., Inc., Fabrics and Finishes Dept., Wilmington 98, Del. The new material has lower permeability, lower heat sealing and laminating temperatures, and lower moisture absorption compared to TFE resin-coated fabrics. KEY NO. 641

▸ Short-run lots of DAP-impregnated papers for decorative laminates are now avaliable at quantity prices; 50-lb rolls in eight patterns can be obtained at the minimum paper price that customarily applies to an order of 10,000 lb or more. The papers are available from FMC Corp., 161 E. 42nd St., New York 17. KEY NO. 642

Finishes

▸ A new epoxy baking enamel is designed to simulate brass on steel and aluminum parts. The coating, called Golden Glow, is available from Flood & Conklin, Industrial Finishes Div., 136 Chestnut St., Newark 5, N. J. KEY NO. 643

▸ A hardfacing alloy known as No. 97 is intended for general purpose use where a hard, machinable deposit is required. Multilayer and single overlays made with the electrode have a Rockwell hardness of C50 to C54. The electrode is available in wire form from Coast Metals, Inc., Little Ferry, N. J. KEY NO. 644

▸ A new exterior and interior grade of clear varnish has been introduced by Patterson-Sargent Co., Kopp & 38th Sts., Cleveland. The varnish, called Super Spar, is made with a polyurethane resin that enables the varnish to resist abrasion, boiling water, dry ice, acids, ammonia, oil, gasoline and alkalis. KEY NO. 645

▸ A 24-karat gold solution is designed for plating electronic parts. The solution, designated Aurall, is available from Lea-Ronal, Inc., 130-19 180th St., Jamaica, N. Y. Deposits are said to be lustrous, ductile and free from porosity. KEY NO. 646

Adhesives

▸ An air-drying, synthetic rubber-base adhesive bonds skin materials such as aluminum, galvanized steel and porcelain enameled steel to such core materials as paper honeycomb, hardboard, asbestos board, foamed glass and some foamed plastics. Called D-218, the adhesive is sold by Armstrong Cork Co., Industrial Div., Lancaster, Pa. KEY NO. 647

▸ A fast-drying, noninflammable adhesive for bonding polyurethane and rubber foams has been developed by Anchor Adhesives Corp., 36-23 164th St., Flushing, N. Y. The adhesive, designated Ank-Seam, is free from toxic solvents such as carbon tetrachloride. KEY NO. 648

▸ A neoprene rubber-base adhesive is recommended for bonding wood, rubber, metals, paper, leather and plastics to themselves and to other materials. The air drying adhesive is marketed by Magic Iron Cement Co., Inc., 14215 Caine Ave., Cleveland 28. KEY NO. 649

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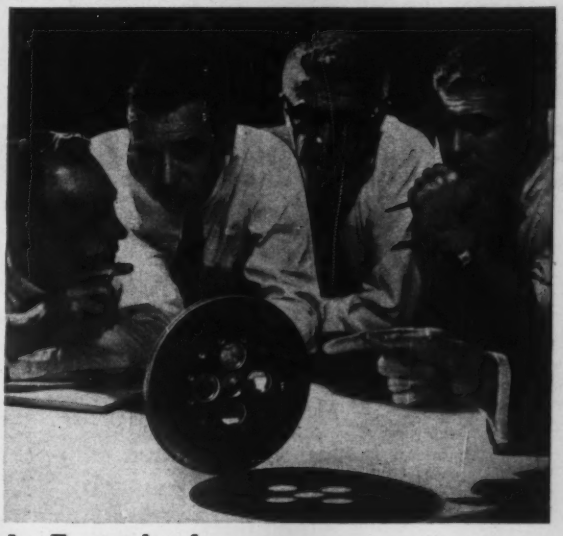

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MATERIALS SELECTOR REFERENCE DATA ISSUE

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THE LAST WORD

H. R. CLAUSER, EDITOR

SILVER-PLATED SALAMI If you think you have tough engineering problems to solve, you can sympathize with the fellows at Tri-Pact Plating Co. in New York who recently were given the job of producing a silver-plated salami. This extra-special salami was to be given as a prize to the top salesman in Sandura Co., a vinyl floor company manufacturer.

Needless to say, there were a great many technical problems to solve such as finding a way to metallize the salami so that it would take a plate, getting rid of the garlic fumes, and avoiding electrode contamination by salami ingredients. But I suspect that these were minor compared to the major problem of keeping the boys in the shop from snitching the salamis to use in their hero sandwiches.

CAREER KIT Want your son to be a metallurgist or a materials engineer? A good way to get him (or any high school student) interested is to tell him about a metal science lab kit recently put on the market. Better yet, buy it for him. The price is only around $40.

Developed by the American Society for Metals and produced by the Materials Science Center, the kit contains the necessary materials and equipment, including a small furnace capable of temperatures up to 1900 F, to perform actual experiments in just about all phases of metallurgy.

A few of over 100 experiments that can be performed with the kit involve cold working of metals, heat treatment, corrosion tests and mechanical property determinations. I can think of no better way than a kit of this kind to arouse the interest of high school students in a career in the materials field.

PIN MONEY About this time every December, when the Christmas bills are mounting, most of us are looking around for extra pin money. May we suggest that one source could be M/DE's 6th Annual Awards Competition for Best Use of Engineering Materials. As you will see from the descriptive folder, p 103, cash awards totaling $1500 will be given again this year to 16 winners. So, why not review your 1961 projects, pick the best one and enter it. Even if it doesn't win, there is still the chance that it might be published, in which case it would be paid for at our usual rates.

ELIMINATING A PROBLEM There is practically nothing these days that escapes close engineering scrutiny and analysis. For example, Paper No. 229B of the Society of Automotive Engineers discusses the matter of air toilet design. The abstract of the paper reads as follows:

"The (toilet) system was developed and tested in an apparently thorough manner. But when it entered airline service, filters clogged in early flights, with consequent stalling of pumps and inoperative toilets. The toughness of the toilet paper procured by some airlines as compared with that used in the Douglas tests was a major cause of these cloggings. So, it would appear, one must obtain worldwide samples of toilet papers, if one is to test such a system thoroughly for transports destined for worldwide service . . . or for the tests, use a paper tougher than any that conceivably might be used."

International designers work in AVISUN polypropylene.....

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Plastic bathroom fixture from Sweden won design prize.
Colorful Japanese combs are strong, flexible, inexpensive.
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Swedish warm air blower needs light, heat resistant case.

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A Swedish manufacturer chose it for the housing of an automobile rear window hot air blower because of its low cost and heat resistance. A Swedish designer won first prize at the Swedish Plastics Federation for the best designed product with his bathroom fixture of high-gloss polypropylene. A Japanese comb maker uses AviSun polypropylene because of its strength and pleasant "feel." And Switzerland produces the humidifier with base, case and cover of polypropylene—chosen for its heat resistance, ease of molding and low coefficient of water absorption.

For information on data and uses for new polypropylene, write to us.

AVISUN*

AVISUN CORPORATION
Executive Offices
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1345 Chestnut St., Philadelphia 7, Pa.

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